

Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices.

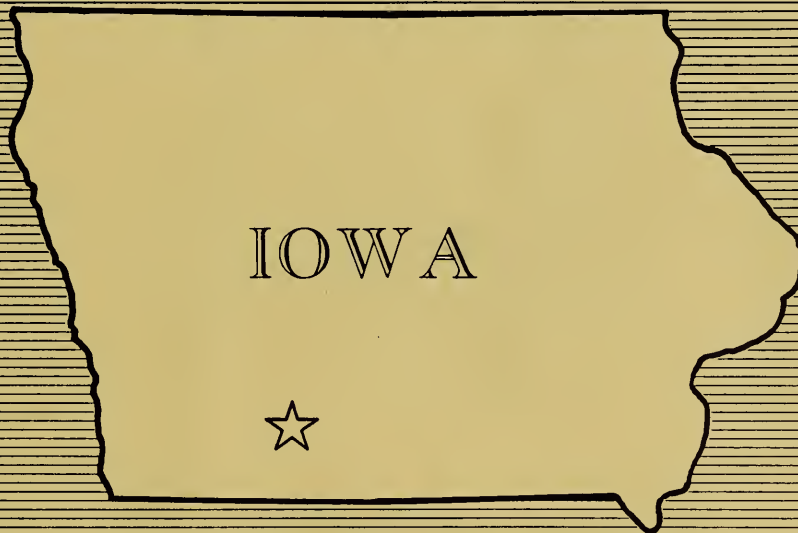
WORK PLAN

FOR WATERSHED PROTECTION AND FLOOD PREVENTION

a1C425
.T85U5

TWELVE MILE CREEK WATERSHED

Union, Adair, and Ringgold Counties
Iowa



AD-33 ~~Boyle~~
9-69

NATIONAL

**A
G
R
I
C
U
L
T
U
R
A
L**



LIBRARY

ADDENDUM

TWELVE MILE CREEK WATERSHED PROJECT, IOWA

This Addendum shows the project costs, benefits, and benefit-cost ratio based on a 6-7/8 percent interest rate and current normalized prices. Annual project costs, benefits, and benefit-cost ratio are as follows:

1. Project costs are \$207,903
2. Project benefits are \$259,330
3. The project benefit-cost ratio is 1.2 to 1

The alternative selected for implementation, as contained in this work plan, is based on a careful and deliberate consideration of the environmental and economic impacts of the project. There are no known unresolved environmental issues. Comments on the draft environmental statement stressed the need for a more detailed description of the effects of this project on water quality. The final environmental statement has been modified in response to such comments.

December 1973



WATERSHED WORK PLAN

TWELVE MILE CREEK WATERSHED
Adair, Union and Ringgold Counties, Iowa

(50,030 ac. or 78.17 sq. mi.)

Prepared Under the Authority of the Watershed
Protection and Flood Prevention Act (Public Law
566, 83d Congress, 68 Stat. 666) as amended.

MAR 25 1975

CATALOGING . PREP.

Prepared by: Adair County Soil Conservation District
Union County Soil Conservation District
Union County Board of Supervisors
State Conservation Commission
City of Creston
Creston Board of Waterworks Trustees

With Assistance by

U. S. Department of Agriculture, Soil Conservation Service
U. S. Department of Agriculture, Forest Service

February 1972

TABLE OF CONTENTS

	Page
WORK PLAN AGREEMENT	iv
SUMMARY OF PLAN	1
DESCRIPTION OF THE WATERSHED	5
Physical Data	5
Location and Size	5
Soils	5
Topography	6
Climate	6
Land Use and Treatment Data	6
Economic Data	7
Fish and Wildlife Resource Data	9
WATERSHED PROBLEMS	9
Floodwater Damage	10
Sediment Damage	11
Erosion Damage	11
Sheet Erosion	11
Gully Erosion	11
Indirect Damages	12
Problems Relating to Water Management	12
Municipal and Industrial Water	12
PROJECTS OF OTHER AGENCIES	13
PROJECT FORMULATION	13
WORKS OF IMPROVEMENT TO BE INSTALLED	14
Land Treatment Measures	14
Structural Measures	17
Drop Inlet Structure, Detention Type	17
Drop Spillway	18
Mitigation Measures	18
Facilities for Incidental Recreation	19
Relocation Payments	19
EXPLANATION OF INSTALLATION COSTS	20
EFFECTS OF WORKS OF IMPROVEMENT	23
Effects of Land Treatment Measures	23
Effects of Structural Measures	24
Effects on Fish and Wildlife Resources	26
PROJECT BENEFITS	27

TABLE OF CONTENTS (Continued)

	Page
COMPARISON OF BENEFITS AND COSTS	28
PROJECT INSTALLATION	28
Land Treatment Measures	28
Structural Measures	29
FINANCING PROJECT INSTALLATION	32
PROVISIONS FOR OPERATION AND MAINTENANCE	33
Land Treatment Measures	33
Structural Measures	34
TABLES	
Table 1 - Estimated Project Installation Cost	36-37
Table 1A - Status of Watershed Works of Improvement	38
Table 2 - Estimated Structural Cost Distribution	39-42
Table 2A - Cost Allocation and Cost Sharing Summary	43
Table 3 - Structural Data - Structures with Planned Storage Capacity	44-47
Table 3B - Structural Data - Grade Stabilization Structures	48
Table 4 - Annual Costs	49
Table 5 - Estimated Average Annual Flood Damage Reduction Benefits	50
Table 6 - Comparison of Benefits and Costs for Structural Measures	51
Table 7 - Construction Units	52
INVESTIGATIONS AND ANALYSES	53
Land Use and Treatment Studies	53
Erosion Investigation	53
Gully Erosion	54
Sheet Erosion	55
Sediment Damage	56
Other Damages	56
Geologic Investigation	56
Hydraulic and Hydrologic Investigations	57
Economic Investigations	59
Engineering Design and Cost Estimates	62
MAP - Figure 1, Project Map	

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

WATERSHED WORK PLAN AGREEMENT

between the

ADAIR COUNTY SOIL CONSERVATION DISTRICT
UNION COUNTY SOIL CONSERVATION DISTRICT
UNION COUNTY BOARD OF SUPERVISORS
STATE CONSERVATION COMMISSION
CITY OF CRESTON

CRESTON BOARD OF WATERWORKS TRUSTEES
in the State of Iowa

(hereinafter referred to as the Sponsoring Local Organizations)

and the

SOIL CONSERVATION SERVICE
United States Department of Agriculture
(hereinafter referred to as the Service)

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organizations for assistance in preparing a plan for works of improvement for the Twelve Mile Creek Watershed, State of Iowa, under the authority of the Watershed Protection and Flood Prevention Act (P.L. 566, 83d Congress, 68 Stat. 666) as amended; and

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the Sponsoring Local Organizations and the Service a mutually satisfactory plan for works of improvement for Twelve Mile Creek Watershed, State of Iowa, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organizations and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan can be installed in eight years.

It is mutually agreed that in installing and operating and maintaining the works of improvement substantially in accordance with the terms, conditions and stipulations provided for in the watershed work plan:



1. Except as hereinafter provided, the Sponsoring Local Organizations will acquire without cost to the Federal Government such land rights as will be needed in connection with the works of improvement. (Estimated cost \$589,680). The percentages of this cost to be borne by the Sponsoring Local Organizations and the Service are as follows:

<u>Works of Improvement</u>	<u>Sponsoring Local Organizations</u> (percent)	<u>Service</u> (percent)	<u>Estimated Land Rights Cost</u> (dollars)
All structural measures	100	0	565,780
Intake str., pumping plant, and pipeline	100	0	10,000
Legal fees, survey costs, flowage easements, and other	100	0	13,900

2. The Sponsoring Local Organizations will provide relocation advisory assistance services and make the relocation payments to displaced persons as required by the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, 84 Stat. 1894) effective as of January 2, 1971, and the Regulations issued by the Secretary of Agriculture pursuant thereto. Prior to July 1, 1972, the Sponsoring Local Organizations will comply with the real property acquisition policies contained in said Act and regulations to the extent that they are legally able to do so in accordance with their State law. After July 1, 1972, the real property acquisition policies contained in said Act shall be followed in all cases.

The Service will bear 100 percent of the first \$25,000 of relocation payment costs for any person, business, or farm operation displaced prior to July 1, 1972. Any such costs for a single dislocation in excess of \$25,000 and all costs for relocation payments for persons displaced after July 1, 1972, will be shared by the Sponsoring Local Organizations and the Service as follows:

	<u>Sponsoring Local Organization</u> (percent)	<u>Service</u> (percent)	<u>Estimated Relocation Payment Costs</u> (dollars)
Relocation Payments	57.3	42.7	47,500

3. The Sponsoring Local Organizations will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to State law as may be needed in the installation and operation of works of improvement.
4. The percentages of construction costs of structural measures to be paid by the Sponsoring Local Organizations and by the Service are as follows:

<u>Works of Improvement</u>	<u>Sponsoring Local Organizations</u> (percent)	<u>Service</u> (percent)	<u>Estimated Construction Cost</u> (dollars)
1 Multi-Purpose Str. (M-1)	47.4	52.6	485,150
Intake Str., pumping plant, and pipeline	100	0	400,000
All other structural measures	0	100	885,720

5. The percentages of the engineering costs to be borne by the Sponsoring Local Organizations and the Service are as follows:

<u>Works of Improvement</u>	<u>Sponsoring Local Organizations</u> (percent)	<u>Service</u> (percent)	<u>Estimated Engineering Cost</u> (dollars)
1 Multi-Purpose Structure (M-1)	47.4	52.6	45,000
Intake Str., pumping plant, and pipeline	100	0	40,000
All other structural measures	0	100	175,300

6. The Sponsoring Local Organizations and the Service will each bear the costs of Project Administration which it incurs, estimated to be \$26,840 and \$198,070 respectively.
7. The Sponsoring Local Organizations will obtain agreements from owners of not less than 50 percent of the land above each reservoir and floodwater retarding structure that they will carry out conservation farm or ranch plans on their land.

8. The Sponsoring Local Organizations will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.
9. The Sponsoring Local Organizations will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.
10. The Sponsoring Local Organizations will be responsible for the operation and maintenance of the structural works of improvement by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.
11. The costs shown in this agreement represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.
12. This agreement is not a fund obligating document. Financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the appropriation of funds for this purpose.

A separate agreement will be entered into between the Service and the Sponsoring Local Organizations before either party initiates work involving funds of the other party. Such agreement will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

13. The watershed work plan may be amended or revised, and this agreement may be modified or terminated, only by mutual agreement of the parties hereto.
14. No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom, but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.
15. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964 and the regulations of the Secretary of Agriculture (7 C.F.R. Sec. 15.1-15.12), which provide that no person in the

The first part of the paper discusses the importance of the study and the objectives of the research. It also mentions the scope of the study and the limitations of the study.

The second part of the paper discusses the methodology used in the study. It mentions the data sources and the data collection methods used in the study.

The third part of the paper discusses the results of the study. It mentions the findings of the study and the conclusions drawn from the study.

The fourth part of the paper discusses the implications of the study. It mentions the practical implications of the study and the theoretical implications of the study.

The fifth part of the paper discusses the limitations of the study. It mentions the limitations of the study and the areas for future research.

The sixth part of the paper discusses the conclusion of the study. It mentions the overall conclusion of the study and the key findings of the study.

The seventh part of the paper discusses the references of the study. It mentions the references used in the study and the sources of the study.

The eighth part of the paper discusses the appendix of the study. It mentions the appendix of the study and the additional information provided in the appendix.

The ninth part of the paper discusses the bibliography of the study. It mentions the bibliography of the study and the list of references used in the study.

United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any activity receiving Federal financial assistance.

ADAIR COUNTY SOIL CONSERVATION DISTRICT

Local Organization

By _____

Title _____

Address _____

Zip Code

Date _____

The signing of this agreement was authorized by a resolution of the governing body of the Adair County Soil Conservation District adopted at a meeting held on _____ 19____.

Secretary, Local Organization

Address _____

Zip Code

Date _____

UNION COUNTY SOIL CONSERVATION DISTRICT

Local Organization

By _____

Title _____

Address _____

Zip Code

Date _____

The signing of this agreement was authorized by a resolution of the governing body of the Union County Soil Conservation District adopted as a meeting held on _____ 19____.

Secretary, Local Organization

Address _____

Zip Code

Date _____

THE UNIVERSITY OF CHICAGO
LIBRARY

THE UNIVERSITY OF CHICAGO
LIBRARY
1215 EAST 58TH STREET
CHICAGO, ILL. 60637

THE UNIVERSITY OF CHICAGO
LIBRARY
1215 EAST 58TH STREET
CHICAGO, ILL. 60637

THE UNIVERSITY OF CHICAGO
LIBRARY
1215 EAST 58TH STREET
CHICAGO, ILL. 60637

THE UNIVERSITY OF CHICAGO
LIBRARY
1215 EAST 58TH STREET
CHICAGO, ILL. 60637

THE UNIVERSITY OF CHICAGO
LIBRARY
1215 EAST 58TH STREET
CHICAGO, ILL. 60637

UNION COUNTY BOARD OF SUPERVISORSLocal Organization

By _____

Title _____

Address _____

Zip Code _____

Date _____

The signing of this agreement was authorized by a resolution of the Union County Board of Supervisors, governing body of Union County adopted as a meeting held on _____ 19____.

County Auditor

Address _____

Zip Code _____

Date _____

STATE CONSERVATION COMMISSIONLocal Organization

By _____

Title _____

Address _____

Zip Code _____

Date _____

The signing of this agreement was authorized by a resolution of the State Conservation Commission, adopted at a meeting held on _____ 19____.

Director for Commission

Address _____

Zip Code _____

Date _____



CITY OF CRESTON
Local Organization

By _____
Title _____
Address _____ Zip Code _____
Date _____

The signing of this agreement was authorized by a resolution of the City Council of Creston, Iowa adopted at a meeting held on _____
19____.

Secretary

Address _____ Zip Code _____
Date _____

CRESTON BOARD OF WATERWORKS TRUSTEES
Local Organization

By _____
Title _____
Address _____ Zip Code _____
Date _____

The signing of this agreement was authorized by a resolution of the Creston Board of Waterworks Trustees adopted at a meeting held on _____
19____.

Secretary

Address _____ Zip Code _____
Date _____

Appropriate and careful consideration has been given to the environmental statement prepared for this project and to the environmental aspects thereof.

SOIL CONSERVATION SERVICE
United States Department of Agriculture

By _____
Administrator

Date _____

WATERSHED WORK PLAN

TWELVE MILE CREEK WATERSHED Adair, Union, and Ringgold Counties, Iowa

February 1972

SUMMARY OF PLAN

Participating Organizations

The Work Plan for Twelve Mile Creek Watershed, Adair, Union, and Ringgold Counties, Iowa, was prepared by the Adair and Union County Soil Conservation Districts, hereinafter referred to as the Adair and/or Union Districts; the Union County Board of Supervisors, hereinafter referred to as Union County; the City of Creston; the Creston Board of Water Works Trustees, hereinafter referred to as the Water Board; and the State Conservation Commission; as joint local sponsoring organizations. Technical assistance was provided by the United States Department of Agriculture, Soil Conservation Service, hereinafter referred to as the Service. The forest land treatment phase of the work plan was developed cooperatively by the Iowa Conservation Commission, Forestry Section and the U. S. Forest Service.

Description of the Watershed

Twelve Mile Creek Watershed, located in south central Iowa about eight miles east of Creston, contains 50,030 acres or 78.17 square miles. The watershed is long and narrow being about 26 miles long and five miles across at its widest point. Twelve Mile Creek, which heads in Adair County, is a right bank tributary to the Thompson River and flows in a southeasterly direction. The Thompson River is locally commonly called the Grand River.

Watershed Problems

Floodwater damage to crops and pasture is a major problem on the bottomlands along Twelve Mile Creek. Inadequate channel capacity causes frequent flooding of these areas. A 100-year frequency flood inundates 2,272 acres of land. The average annual area flooded is 1,104 acres. The average annual floodwater damage is \$52,930 (Table 5).

Gully erosion is a major problem in the upland areas of the watershed and damages land in two principal ways. It destroys land by creating a void where the gully is formed. This voided area then lowers or depreciates the utility of the land adjacent to it by dissection of fields making portions inaccessible. This causes cropland to depreciate to pasture or idle areas. The average annual rate of voiding is 13.84 acres and of depreciation 18.71 acres. Damages also occur to other agricultural and non-agricultural facilities. The average annual gully erosion damage is \$29,490 (Table 5).

The City of Creston, population 8,234, has requested the inclusion of municipal and industrial water supply storage as part of the project. The City presently has two small water supply reservoirs and is a partner with the State of Iowa and the Central Iowa Power Cooperative in the Green Valley Lake development. The City is allowed to withdraw a limited amount of water from Green Valley Lake. This latter lake is owned by the State of Iowa with a major purpose of recreation. Present agreements do not provide the City sufficient water to permit expansion or development of high-water-use industries in the community.

Planned Works of Improvement

The project for the protection and development of the watershed will be installed during an eight year project installation period at a total cost of \$3,690,790 (Table 1). The P.L. 566 share of the cost is \$1,575,823 and the other or local share is \$2,114,967.

Land treatment measures will be installed on most of the cropland areas where sheet erosion is a problem. The land treatment measures to be installed include parallel and gradient terraces, contouring, grassed waterways, pasture improvement, woodland improvement, and conservation cropping systems. The installation cost of these measures is estimated to be \$797,530 of which \$17,590 is for accelerated technical assistance to be provided from P.L. 566 funds. The remaining \$779,940 will be borne by the landowners, State funds, and Federal funds provided under authorities other than P.L. 566. Land treatment measures will be maintained by the landowners and/or operators of the farms on which these measures are installed in accordance with cooperative agreements entered into with the respective Districts.

The project provides that 11 grade stabilization structures, 22 floodwater retarding structures and one multiple-purpose structure for flood prevention and municipal and industrial water supply will be installed during the eight year project installation period. The estimated installation costs of the structural measures are \$2,893,260. Of this, P.L. 566 funds will bear \$1,558,233 and other or local funds will bear \$1,335,027.

The structural measures, except structure M-1, will be operated and maintained by the Union District and Union County using tax revenues available from a county-wide tax on agricultural lands in Union County. Structure M-1 will be maintained by Union District, Union County, and the City of Creston. The estimated average annual operation, maintenance, and replacement cost of the structural measures is \$8,760 (Table 4).

Project Benefits

The benefits of the project have important effects on the inhabitants and agricultural land in the watershed. Of the 346 farms in the watershed, benefits to land from reduction of gully erosion damage will accrue to 107 farms. Floodwater damage reduction benefits and land enhancement benefits will accrue to 54 farms. Additional benefits will accrue to roads, fences, bridges, building, etc. in the form of damage reduction and reduction of future costs of improvements. Sheet erosion will be reduced by land treatment measures on most of the farms in the watershed.

Water will be stored in the sediment pools of 32 of the project structures in addition to structure M-1. Many of these pools will be stocked with fish by landowners or other local groups. Wildlife plantings for food and cover will be made at some of these sites. The pools will provide local residents with fishing, picnicking, boating, swimming, and waterfowl shooting opportunities. Some of these areas may be developed and used as income producing enterprises on the farms.

Multiple-purpose structure M-1 will provide the City of Creston with an adequate and reliable source of water for present and projected domestic and industrial expansion.

The reservoir will have a normal water surface area of 633 acres. The City intends to develop selected small portions of the surrounding purchased area for access for parking and with sanitary facilities for use of boaters and fishermen who wish to use the water area.

The average annual primary, secondary, and incidental recreation benefits accruing to the structural measures are as follows:

Gully erosion damage reduction benefits	\$28,610
Floodwater damage reduction benefits	45,040
Land enhancement benefits	21,000
Sediment damage reduction benefits	1,400
Municipal water benefits	58,800
Incidental recreation benefits	20,500
Secondary benefits	6,210
Indirect	8,120
Downstream floodwater damage reduction	<u>13,910</u>
Total	\$203,590

The average annual benefits of the structural measures are \$203,590, the average annual costs are \$165,070, the benefit-cost ratio is 1.23 to 1.0 (Table 6).

General

There are 346 farms located entirely or partially within the watershed. There are 199 farms, 34,995 acres, cooperating with the District in installing land treatment measures. Conservation plans have been developed on 150 farms, 26,896 acres, or 53 percent of the watershed area. Local landowners and operators have installed land treatment measures valued at \$752,930 (Table 1A).

DESCRIPTION OF THE WATERSHED

Physical Data

Location and Size: The Twelve Mile Creek Watershed is located in south central Iowa about eight miles east of Creston. The watershed is 50,030 acres in size; of this, 47,770 acres is in Union County, 2,000 acres in Adair County, and 260 acres in Ringgold County. The drainage area is long and narrow being 26 miles long and five miles across at its widest point. Twelve Mile Creek, which heads in Adair County, is a right bank tributary of the Thompson River and flows in a southeasterly direction.

Soils: The loess soils of the watershed are Grundy and Sharpsburg. These soils, found on the flat and gently rolling ridges, were developed under grass vegetation from Wisconsin loess. The soils are moderate to imperfectly drained because of their fine textured B horizon. Both soils can be improved for crop production by applying recommended amounts of fertilizer. Sheet erosion is a serious problem on the moderate to steep slopes that are not protected by conservation treatment measures.

The upland soils on steeper slopes are Shelby and some Lindley. Shelby is a moderately dark colored soil developed under prairie vegetation from Wisconsin glacial till, principally Kansan. The surface 23 inches contain about 34 percent sand, 33 percent silt, and 33 percent clay. Below 23 inches, the Shelby soil changes only little in texture. The Grundy soils are dark colored and fine textured. The top 40 inches consists of about 40 to 45 percent silt and 55 to 60 percent clay. This is a very good producing soil.

The Sharpsburg soils are dark colored, well drained, medium to fine textured. The surface 12 inches contains three percent sand, 61 percent silt and 36 percent clay; 12 inches to 30 inches contains one percent sand, 65 percent silt and 34 percent clay; from 30 inches to 72 inches contains about two percent sand, 70 percent silt, and 28 percent clay. Erosion control is the main problem. This is also a very productive soil.

The upland soils in and near the drainageways are predominantly alluvial. These soils are similar to, although somewhat heavier in texture than, the adjacent soils. Productivity is usually quite high.

The main bottomland soils on the Twelve Mile Creek Watershed floodplain are Colo-Zook complex, Colo silty clay loam and Nodaway silt loam. Many of these are heavy textured throughout their profile, dark colored, moderate to imperfectly drained and subject to frequent overflow. With proper protection and drainage, these soils are highly productive.

Topography: The topography of the watershed is classed as mature. The watershed is narrow and has highly meandering intermittent streams bounded by nearly vertical, water eroded banks. The major part is gently rolling to rolling (5-18 percent slopes), however, the upper area of the watershed has some level to nearly level areas (0-2 percent slopes). The natural drainage system of the watershed is well developed. Drainageways extend into practically every quarter section of land in the area and well towards the top of the ridges.

Climate: The climate of the watershed is of the extreme midcontinental type. The spring season may fluctuate from wet to fairly dry. Hot winds and periods of prolonged high temperatures are common in the summer season.

Climatic data are based on 50 years of records from the U. S. Weather Bureau station located at Afton located on the eastern edge of the watershed. Extreme temperatures range from -22 degrees to +112 degrees. The average frostfree crop growing season is 163 days. The average date for the last killing frost in spring is April 30 and the average date for the first killing frost in autumn is October 10.

Precipitation has varied from a maximum of over 43 inches to a minimum of about 24 inches with an average of 33.3 inches annually. Mean snowfall averages about 30 inches per year.

Land Use and Treatment Data

The land use of the watershed, both present and planned is listed below:

<u>Land Use</u>	<u>Without Project</u>		<u>With Project</u>	
	<u>Percent</u>	<u>Acres</u>	<u>Percent</u>	<u>Acres</u>
Cropland	54	26,857	52	26,199
Pasture	30	15,089	27	13,600
Forest Land	11	5,325	11	5,227
Other	5	2,759	10	5,004 ^{1/}
	<u>100%</u>	<u>50,030</u>	<u>100%</u>	<u>50,030</u>

^{1/} This acreage includes land within the take line at site M-1, acres of wildlife habitat development and approximate surface acres of water in watershed structures and local farm ponds, along with acres in farmsteads, roads, etc.

The predominant rotations range from an intensive corn and soybean cropping pattern on the bottomlands to a rotation of corn, oats, and four years meadow as the extreme in the upland areas.

Approximately 11 percent (5,325 acres) of the watershed is in forest cover. About 50 percent of that area is in very poor hydrologic condition and the remaining 50 percent in poor hydrologic condition. The proposed forest land treatment program will help control surface runoff, reduce sediment, and improve forest soil and stand conditions. Continued protection and more intensive management would result in the forest land being in fair hydrologic condition by the end of the evaluation period.

The general cover conditions of the watershed are classed as good. Conservation crop rotations provide protection from runoff on portions of the cropland but intertilled corn and soybeans predominate. Some pastures are being overgrazed but most have adequate cover.

Economic Data

The major farm enterprise in the county and watershed is the production of cattle and hogs. According to the 1964 U. S. Census of Agriculture, 63 percent of the farms in the county are livestock farms; this is considered to be representative of the watershed area. Cash-grain farms make up 16 percent of the total. The principal crops produced are corn, soybeans, hay and oats. Since only relatively small areas of the watershed are located in Adair and Ringgold Counties, the Agricultural Census data presented below based on Union County is assumed to apply to the entire watershed.

There are 346 farms located entirely or partially within the watershed. Approximately 62 percent of the farms are owner-operated. The average size of farm is 255 acres. The average value of land and buildings per farm is \$37,500 or \$147 per acre. The value of all farm products sold in 1964 was \$10.2 million. This averaged about \$10,000 per farm.

Creston (8,234) is the main marketing and distribution center in the immediate vicinity of the watershed. The towns of Afton (823), Arispe (93), and Spaulding (unincorporated), lie partially within or adjacent to the watershed. The 1964 Agriculture Census indicates that 26 percent of the farm operators had off-farm employment; 11 percent worked 100 days or more.

The number of people living on farms in Union County decreased from 3,674 in 1960 to 2,817 in 1968.

The following table indicates the trend in the size of farms in the watershed. It is to be noted that family type farms are being maintained in the watershed and make up the greater percent of all farms.

Farm Size		Union County				Watershed	
		1959		1964		1969	
(Acres)		No.	%	No.	%	No.	%
Under 10	42		4	37	4	-	-
10-99	443		47	473	45	125	36
100-199	312		33	371	35	141	41
200-499	138		15	159	15	79	23
500-1,000	8		1	6	1	1	*
1,000+	1		*	2	*	-	-
TOTAL	944		100%	1,048	100%	346	100%

*Less than 1 percent

Adequate transportation facilities are available to the watershed and surrounding communities. U. S. Highways 34 and 169 crisscross the central portion of the watershed. The Burlington Northern, Inc. and the Chicago Great Western Railroads serve the local communities.

The Union County Soil Conservation District was organized May 28, 1943; the Adair County Soil Conservation District, August 9, 1940; and the Ringgold County Soil Conservation District, December 20, 1943. To date, 199 farms, 34,995 acres, or 70 percent of the watershed are under cooperative agreements with the Districts and are installing land treatment measures with technical assistance from the Soil Conservation Service. Conservation plans have been developed on 150 farms, 26,896 acres, or 53 percent of the watershed.

Forest stands of the watershed are 47 percent oak-hickory type, 40 percent mixed hardwood types and 13 percent non-stocked. About six percent of the stands are of sawtimber size, 47 percent are of pole-size and 47 percent are seedling-sapling or non-stocked stands.

Available markets are good for walnut saw logs and veneer logs, and white oak stave bolts. The markets for other local forest products are poor.

Forest fire protection is being provided by local fire departments in cooperation with the Iowa Conservation Commission, Forestry Section, and the U. S. Forest Service through the Clarke-McNary Cooperative Fire Control Program. There are no records of any fires occurring during the past five years. The established state-wide fire loss index goal of 0.10 percent is being met. No increase in fire occurrence is anticipated as a result of the watershed project.

Other available Federal-State forestry programs include Cooperative Forest Management, Cooperative Forestation and Cooperative Insect and Disease Control. This watershed is not located within a regular CFM district, but technical assistance is available from adjacent CFM districts. Given protection, care and management, the forest areas are expected to increase their contributions to the economy of the watershed.

Fish and Wildlife Resource Data: The fishery of Twelve Mile Creek is of minor importance. The upper reach has only token flow except during and following periods of rainfall. The lower reach may at some times support some populations of carp, catfish, and bullheads. However, this sport fishery is too transient to be of much value. Many of the 178 existing farm ponds in the watershed area provide excellent fisheries and provide nesting and resting areas for migratory waterfowl.

A considerable amount of suitable wildlife habitat is found within the watershed. The large amounts of forested areas support many upland game species. The permanent cover associations are connected to fields of cropland and are important to deer, squirrel, rabbits, and pheasants.

The many fence rows, odd corners or areas, windbreaks around farmsteads, grassed waterways, and seeded back slopes of terraces, all serve to some degree as cover and food areas. Quail and songbirds use these areas. There are good populations of common and spotted skunk, raccoon, coyote, and red fox. Mink and muskrat are found in areas of suitable aquatic habitat. Deer are present in limited number.

Local landowners have established 208 acres of wildlife habitat management areas for use of upland game. There are no marsh areas in the watershed.

WATERSHED PROBLEMS

Croplands in the upland areas of the watershed are rolling to steep. A major portion of the cropland is in row crops of corn and soybeans. Sheet erosion is prevalent where corrective conservation treatments have not been applied. Needed land treatment measures such as terraces, contour farming, and waterways are progressively being applied in the watershed. Some areas will need to receive added land treatment emphasis in order to provide for the necessary percentage of land being properly treated above the structural measures to be installed. It is expected that through educational meetings and by demonstrations of the effectiveness of conservation measures that the necessary land treatment measures will be applied during the eight year installation period.

Floodwater Damage: Flooding from Twelve Mile Creek at the present time occurs nearly every year and more often in some reaches. The flooding varies in depth and duration by reaches.

A 100-year frequency flood is estimated to inundate 2,272 acres; a 50-year frequency flood, 2,184 acres; a 25-year frequency flood, 2,080 acres; a five year frequency flood, 1,492 acres; and a one year frequency flood, 314 acres.

The average annual area flooded is 1,104 acres and the average annual floodwater damage to crops and pasture is \$31,050. The average annual floodwater damage to other agricultural facilities is \$8,770 and non-agricultural damages are \$13,110. Other agricultural damages include fences and farm crossings. Non-agricultural damages include roads, bridges, etc.

It is estimated that 53 percent of the floods occur during the months of April, May and June. Floods during these months will reduce yields and cause problems in tillage operations needing to be completed during this time. Crops may sometimes be destroyed. The crop can be replanted or a catch crop may be planted.

Approximately 45 percent of the floods happen during the summer and fall seasons. Floods occurring in these periods often destroy the entire crop. This causes an economic hardship for farmers on the flood plain.

Only two percent of the floods occur during the winter months. Floods at this time of year do not generally cause high monetary losses. Some damage may be done to grasses, new seedings and other agricultural facilities.

Some farmers on an individual basis, have attempted to straighten the channel and clear it of debris. This has little effect on the reduction of flood damages. The economic effect of flooding has been felt throughout the entire watershed. This has prompted local participation to try to alleviate this problem.

Occasionally, spring and summer flooding has a detrimental effect on wildlife habitat. Low-lying habitat provides some nesting cover for game birds. Flooding causes some nests to be destroyed which may reduce the game bird population in this area.

Sediment Damage

Sediment damages occur in isolated areas of the watershed. Annual damages were evaluated at seven locations to be \$1,460. Damages from sediment at other locations were considered as being not significant and therefore, were not evaluated.

Erosion Damage

Sheet Erosion: Excessive sheet erosion is occurring on many of the sloping cropland areas of the watershed. Land treatment measures installed in recent years have corrected this problem on portions of the cropland area. Some steep cropland has been converted to permanent pasture. Continuation of sheet erosion on the untreated erosive areas would cause a gradual decline in the productivity of those areas by further removal of the fertile topsoil.

At present, 41,530 acres or 83 percent of watershed land is considered to be adequately treated; that is, soil losses from sheet erosion are 4.0 tons per acre per year or less. About 8,500 acres is inadequately treated since these areas exceed the 4.0 tons per acre per year tolerable soil loss limits.

Studies to determine the monetary value of damages resulting from declining yields due to sheet erosion were not made; however, the planned land treatment measures will reduce this damage on the treated areas.

Gully Erosion: Gully erosion damage to land is a problem in certain portions of the watershed. It occurs as land voiding and an associated depreciation of the productive capacity of the nearby field areas in a farm unit, especially those areas adjacent to the voided gully area. The laterals which advance from the main gully establish a pattern which makes it necessary to abandon field cropping on most of the areas in between, permitting the use of the land only as pasture or idle areas. These areas cannot be profitably farmed because of their relatively small size, the cost of maintaining crossings, or the extra travel involved. The gullies range in width from 10 to 80 feet and in depth from 5 to 25 feet. If permitted to continue at their present rate, much valuable cropland will be destroyed and the general economy of the local community will deteriorate. It is estimated that about 3,255 acres will be damaged during the 100-year evaluation period if the project is not installed.

The estimated average annual damages to land by voiding and depreciation is \$28,460 (Table 5).

Gully erosion damage also occurs to other agricultural and non-agricultural measures. The sloughing or caving of gully banks causes parallel and cross fences to be frequently damaged and causes undermining of bridge supports and approaches. Annual other agricultural damages are \$820, non-agricultural damages are \$210.

The total damage from gully erosion is \$29,490 each year. Gully erosion damage also occurs in minor areas of the watershed where structural measures are not planned. These were found to be too low to justify a structural measure, but will be partially controlled by land treatment measures. Only damages affected by structural measures were evaluated.

Indirect Damages

Field studies indicated that indirect damages occur in the watershed and consist of increased cost of normal field operations, rerouting of traffic, farm equipment breakage, interruption in pasturage resulting from fence damage, breaking out of livestock, etc. An estimated ten percent of the direct damages were used as a monetary value for indirect damages. The indirect damages are estimated to be \$8,380 annually (Table 5).

Problems Relating to Water Management

Municipal and Industrial Water: The City of Creston and the Water Board have requested the inclusion of storage for municipal and industrial water in structure M-1. The City has experienced numerous years of water shortage. These shortages have become critical with increasing population and industrial growth.

Creston's main source of water presently is Summit Lake with a capacity of 464 million gallons. The present water use in Creston is 270 million gallons per year. During years with low runoff, the 464 million gallons storage is not adequate to supply the present use. Creston also has an agreement with the State Conservation Commission and the Central Iowa Power Cooperative to withdraw water from Green Valley Lake. They can only withdraw the water necessary for health and sanitation needs and this only with the consent of the other two owners of Green Valley Lake. This arrangement has not been satisfactory to the City.

The consultant to the Water Board has estimated a 1990 population of 12,000 for Creston and a water consumption of 1.8 million gallons per day or 657 million gallons per year. To insure a dependable supply of water he recommended providing for storage of three years use in the structure.

The projected 1990 use is greater than the present supply requiring the storage of water for future needs. The present storage is adequate for present needs when runoff is high. Additional storage is presently needed to allow for expansion of existing industry, attraction of new industry, and to meet demands in years of low runoff.

PROJECTS OF OTHER AGENCIES

No other Federal or State agency has an existing or proposed program for water resource development in the watershed that will affect or be affected by the works of improvement included in this work plan.

PROJECT FORMULATION

The Twelve Mile Creek Watershed Project was formulated to include physically and economically feasible systems of measures that will provide for a near optimum solution of the erosion, sediment, and floodwater problems in the watershed, and provide the City of Creston with a reliable and adequate present and future water supply for domestic and industrial uses.

The project objectives agreed to by the Local Sponsoring Organizations and the Service include:

1. Maintenance of soil productivity through the prevention of excessive sheet erosion and removal of soil nutrients by the application of needed land treatment measures.
2. Control or prevent gully erosion to the extent that is economically and physically feasible.
3. Reduce floodwater damages to the extent that is economically and physically feasible.
4. Providing the City of Creston a municipal and industrial water supply not only for critical drouth periods but also for future industrial expansion and for attracting new industries, and future projected domestic use.
5. Safeguarding the fish and wildlife resources of the area by preserving or enhancing suitable habitat for existing fish and wildlife species. It will also be desirable so far as landowners can agree to participate, to provide improvement and enhancement to increase the fish and wildlife resources.

Protection of watershed lands to permit future sustained production was considered necessary. Therefore, installation of land treatment measures that will reduce sheet erosion soil losses so as to maintain or enhance future crop yields was considered to be the basic element of this watershed project.

Flood damages on bottomlands of Twelve Mile Creek seriously affect the economic stability of farms located on the floodplain due to the uncertainty of income. The alleviation of these problems received

special attention in project planning. These bottomlands are presently dedicated to agricultural use. This is the best land use for this area. No urban areas or special hazards exist in the flood plain that would lend themselves to other alternative planning techniques such as flood proofing.

The control of gullies that destroy land and improvements was a major concern. Control measures that will affect only individual farms and which can be installed with cost-sharing from going agricultural programs, were considered as land treatment measures to be installed by local people. Technical assistance will be provided by the Service as needed. Control measures that affect two or more farms and cannot be installed by the individual farmers or groups of farmers were considered as possible project measures for flood prevention which, if found feasible, would be installed with assistance available under authority of P.L. 566.

Grade stabilization and floodwater retarding structures were selected from several alternative combinations or choices that were available. The type of stabilization structure selected was governed by the type most economical to install considering the size of drainage area, the required amount of head control or drop through the structure, the topography at the site, the length of dam, and ease of obtaining temporary storage, etc. A preference in choice was given to detention type stabilizing structures that would also reduce peak flows and trap and retain sediment, thereby further alleviating sediment problems within the watershed.

The inclusion of municipal water supply for Creston as a project objective was considered desirable.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

Land treatment measures are being installed. The project provides for a sound and effective land treatment program to be installed on most of the land on the remaining farms needing treatment during the eight-year project installation period.

Alternative methods of treatment are available. Those measures to be applied will be based on the decisions of the landowners after adequate consideration has been given to those alternatives that are available. For example, to control sheet erosion losses to tolerable limits, an intensive cropping rotation with only moderate amounts of meadow may be used on Class IIIe lands that are terraced and contour farmed. Where contouring alone is used, the rotations must include a higher proportion of meadow and less of the grain and intertilled crops to offset beneficial effects of reduction in slope length due to terraces; or the land may be used for permanent pasture. Similar alternatives are available on other

land classes. Other treatments such as grassed waterways and gully stabilizing structures will be needed in varying amounts depending somewhat upon other treatments selected.

Soil surveys for use in farm planning and for development of land treatment needs have been 75 percent completed in the watershed. These soil surveys provide basic information for planning the definite and alternative land treatments. Standard soil surveys are in progress in the County and will be completed in the watershed area for use in project installation.

Past experience in the watershed has been used as a guide in arriving at estimates of the combinations of treatments that will be applied on the various farms. The following estimates may, therefore, be finally modified to the extent that other alternative treatments are selected and applied.

Terraces are planned for croplands where soils and topography are suitable and where determined practical by the farmer and the District Conservationist. According to records of the District Office, about 69 miles of gradient terraces and eight miles of parallel terraces (seeded back-slope) have been applied in the watershed.

Contour farming is used alone or in combination with terraces. Currently, 10,470 acres of the sloping lands are being farmed on the contour.

Land treatment grassed waterways are natural watercourses which are shaped and seeded to protective vegetation by proper seedbed preparation, fertilizer application, and seeding of suitable grass mixture. These waterways are dependent on stabilized grades to be provided by the downstream structural measures. Approximately 541 acres of waterways have been installed.

A pasture renovation program is underway in the watershed. Poor native grass pastures are improved by renovation and the seeding of suitable grass-legume mixtures. This provides better cover to reduce runoff and increases forage production. About 3,479 acres of pasture have been renovated.

Diversions are planned to intercept hill runoff water and thus protect the land below it. To date, 22 miles have been established.

Land treatment grade stabilization structures are installed by farmers to stabilize gullies and waterways on their individual farms. Twenty-seven of these structures have been installed.

Tile drains are used in waterways and bottomland to alleviate wet areas. Sixty-nine miles have been applied.

Wildlife plantings of food and cover are included in conservation plans in all instances where farmers can be encouraged and agree to do so. About 208 acres of habitat, food and cover plantings have been applied.

Many farm ponds have been installed for water supply for livestock. According to District records, 178 ponds have been installed.

The following program has been developed for forest lands from a statement of land treatment needs prepared by the Iowa Conservation Commission, Forestry Section, and the U. S. Forest Service, as determined from a field survey of the watershed.

A. Tree Planting (32 acres)

Reforestation of appropriate open lands is necessary to adjust land use with capability, and to reduce surface runoff and soil erosion by developing a protective cover of vegetation and absorbent forest floor of litter and humus. Twelve planting plans will be prepared prior to the open field tree planting.

B. Hydrologic Cultural Operations (8 acres)

These silvicultural operations are designed to improve the hydrologic condition of forest lands by manipulating stand composition to create conditions most favorable for the maximum production of litter, humus and forest cover. This includes thinnings; weedings, improvement, salvage and harvest cuttings; supplemental tree planting and stand conversion.

C. Protection from Grazing (96 acres - 2 miles of fence)

Fencing forest land from use by domestic livestock prevents impairment of hydrologic conditions by reducing soil compaction and damage to tree roots, seedlings and other ground cover. Preventing this damage allows litter and humus layers to build up to a desirable level, thereby providing optimum conditions for good infiltration, percolation and storage of moisture in the soil profile.

To provide for the proper installation and maintenance of approved measures, individual management plans will be prepared for approximately 650 acres involving 16 private forestland owners. This service together with other technical assistance to landowners insures that watershed values are not impaired.

Structural Measures

Structural measures to be installed include one multiple-purpose structure for floodwater retarding and municipal water supply, 22 floodwater retarding structures, and 11 grade stabilization structures. Ten of the grade stabilization structures are drop inlet detention type structures and one structure is a full flow straight drop spillway.

Drop Inlet Structure, Detention Type: All but one of the structures included in this project are this type of structure. These structures consist of compacted earthfill dams and principal spillways of precast reinforced concrete pipe or corrugated metal pipe with suitable outlets. In many cases a hooded inlet is used in place of a vertical drop inlet. Sketch SS-15 illustrates the hooded inlet and the propped out-

let. A propped outlet will be used for all except structures M-1, 30, 62-5, 62-4, 67 and 73. Structures 30 and 62-5 will be designed with chute outlets similar to sketch SS-10. Structures 62-4, 67, and 73 will be designed with corrugated metal pipes with hood inlets and corrugated metal chute outlets. These corrugated metal pipes will be replaced after about fifty years to extend their life to 100 years.

The multiple-purpose structure (M-1) for flood prevention, sediment control, and municipal water supply will be designed with a concrete SAF energy dissipator outlet similar to that shown in sketch SS-8. This structure will be provided with a reinforced concrete riser similar to SCS standard covered riser design. A drawdown pipe and manually operated gate will be attached on the upstream side of the riser for water level control if desired, downstream releases, and in maintenance.

An open vegetative earth emergency spillway channel will be provided at one end of the dam for all of the drop inlet detention structures to convey the runoff from storms of greater magnitude than the design storm without causing over-topping of the dam. Sketches SS-2A and SS-10 of drop inlet earth dams show illustrations of this type of emergency spillways.

Storage capacity for sediment is provided in the design of all these detention structures so that the storage for temporary detention and the municipal water will be available throughout their 100-year expected life. The design of structure M-1 provides for 8,000 acre-feet of municipal water to be stored above the 2,200 acre-feet of storage needed for the anticipated 100-year sediment production from the upstream drainage area. The normal pool for this structure is 633 acres.

Nine of the floodwater retarding structures (D-35, D-41A, D-44, D-44-1, D-59, D-60, D-61, D-62A, D-62-1) will have the crest of the concrete riser set at the top of the storage provided for the first 50-year sediment accumulation. Storage for the second 50-year sediment accumulation will be provided for along with the temporary flood storage between the crest of the riser and the vegetated emergency spillway. At the end of the first 50-year period it may be desirable to extend the concrete riser to the elevation of the 100-year sediment accumulation as provided in the plan.

The other 23 drop inlet detention structures are designed with the crest elevation determined by gully stabilization needs and will provide a minimum of 100-year sediment storage below the crest or normal pool elevation.

Of these 23 drop inlet detention structures, 10 of them (62-4, 62-5, 67, 68-1, 68-2, 71, 72-1, 72-2, 73, and 77) are grade stabilization structures. The remaining 13 are floodwater retarding structures with grade stabilization. No problem is anticipated in holding water at the crest elevation to accomplish the needed grade stabilization.

The 33 drop inlet detention type structures will provide normal water reservoir pools totaling 1,194 surface acres. The average normal pool surface area for the 32 smaller single purpose structures is nine acres and range from three to 26 acres in size.

Drop Spillway: Structure 74 is a full flow monolithic concrete drop spillway. It is designed in the watercourse to drop the water from one level to another for gradient control and stabilization of the upstream gully or watercourse. It does not have floodwater retarding features. This type is illustrated in sketch SS-1.

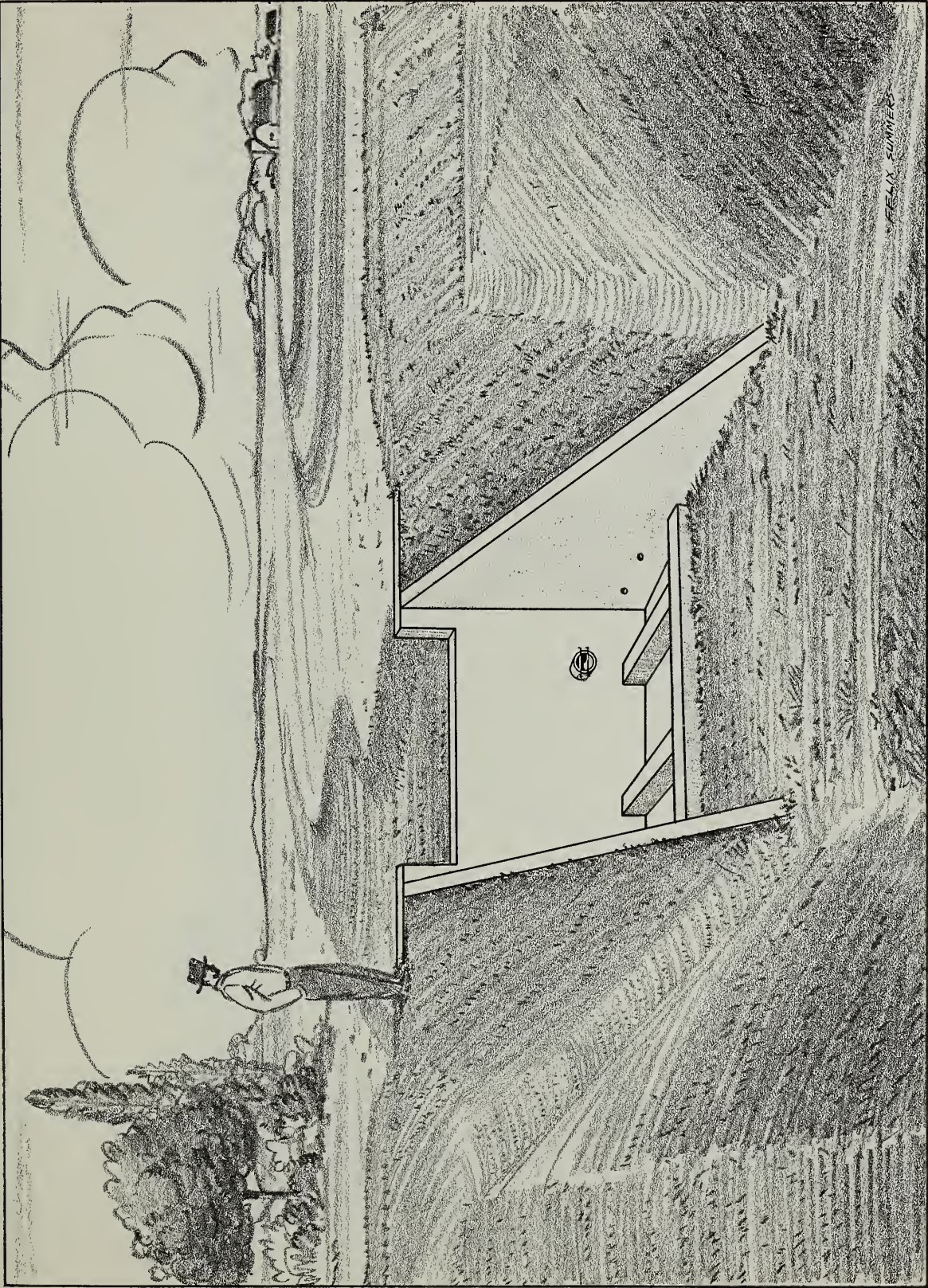
Mitigation Measures

A reconnaissance study and report by the Bureau of Sport Fisheries and Wildlife indicates that a minimum of 155 acres of wildlife habitat should be replaced by mitigation measures. This loss of habitat is estimated to result from construction of dams and water impoundments.

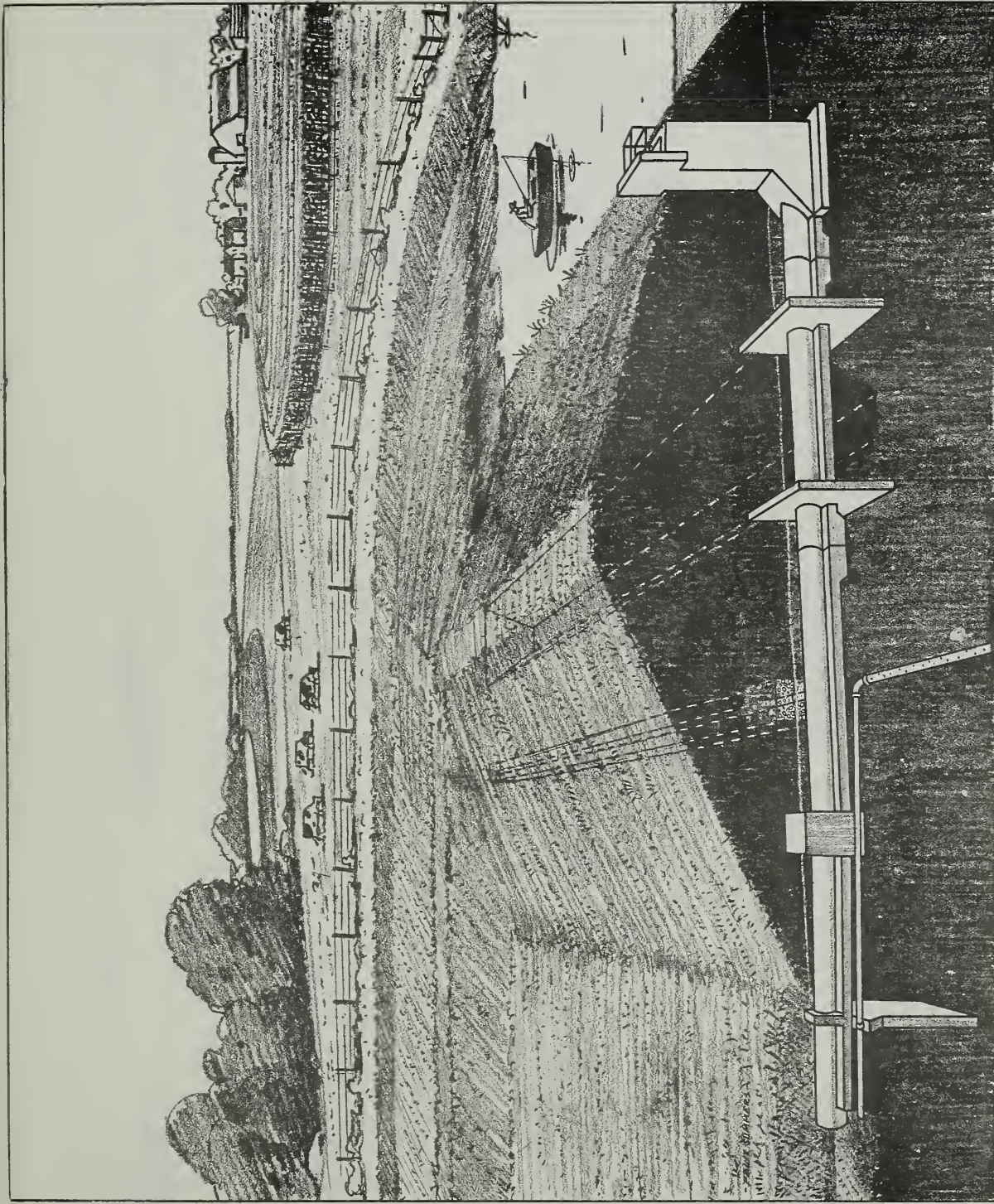
Mitigation of habitat losses is provided for through easements to the State Conservation Commission under their Farm Game Habitat Program in from one to five-acre plots near the impoundments in the watershed. These plots will be planted to wildlife habitat and cover with shrubs and other perennials of various species. The areas will be fenced to exclude livestock unless areas are not accessible to grazing or trampling by livestock.

The following is a list of the structures and acres of mitigation for each site:

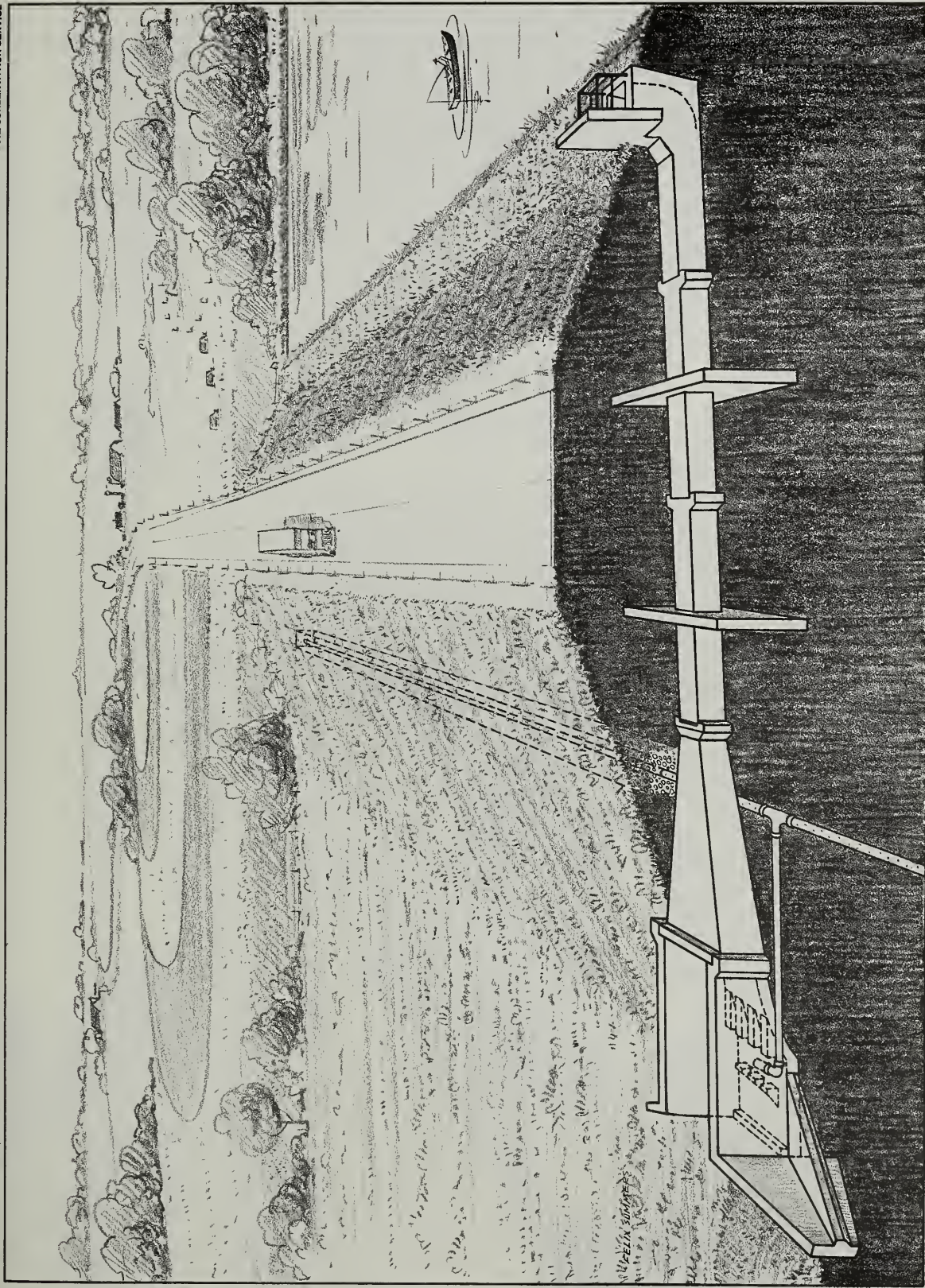
<u>Structure Number</u>	<u>Acres</u>	<u>Structure Number</u>	<u>Acres</u>
17	5	48	2
18	4	49	2
23	3	55	2
27	5	D-59	10
30	3	D-60	7
D-35	8	D-61	5
35-2	4	D-62	4
36	2	D-62A	4
40-1	3	68-1	1
D-41A	14	68-2	1
D-44	9	72-1	1
D-44-1	9	72-2	2
46	3	M-1	42



Drop Spillway

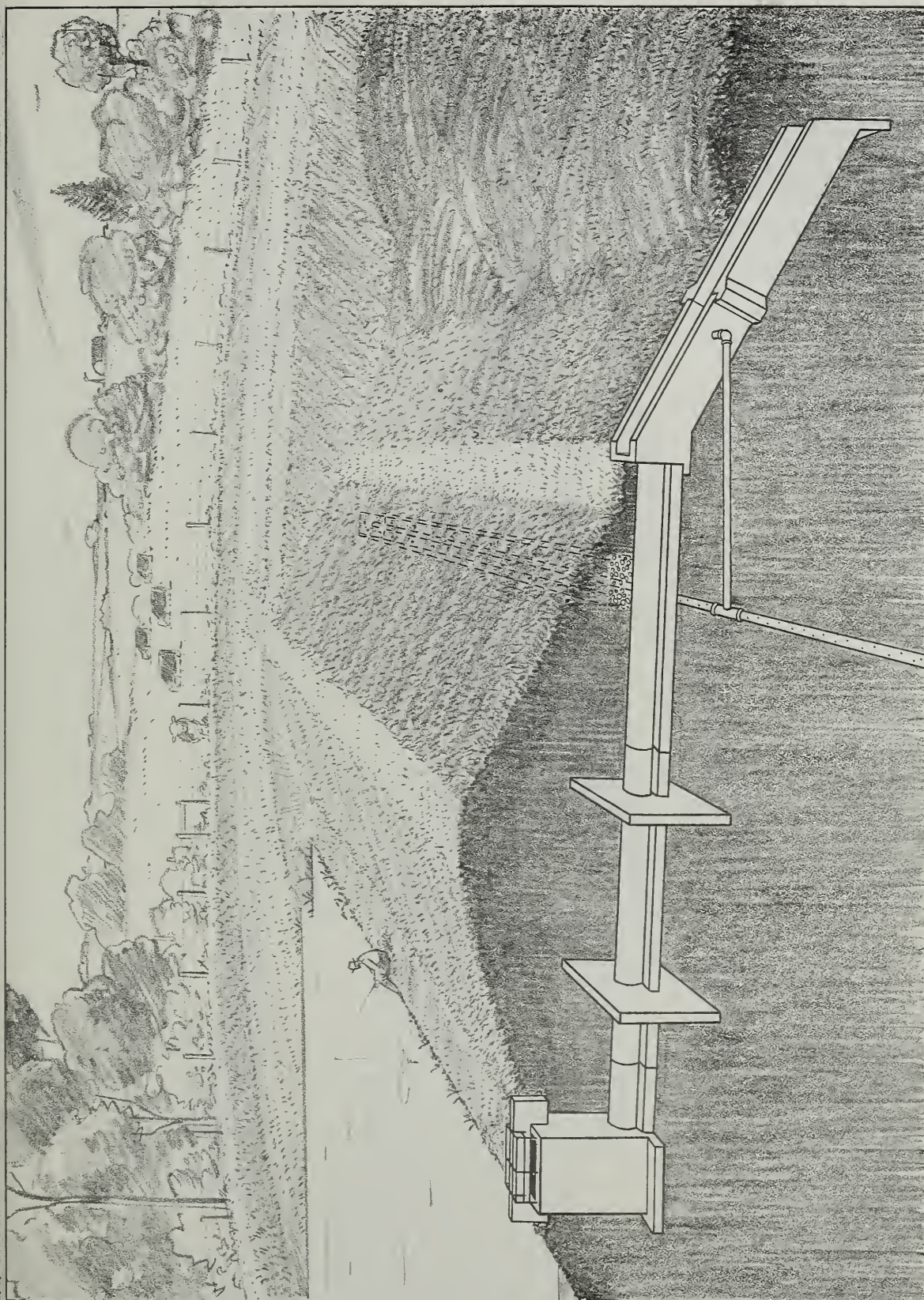


Earth fill dam with concrete drop inlet and conservation pool.

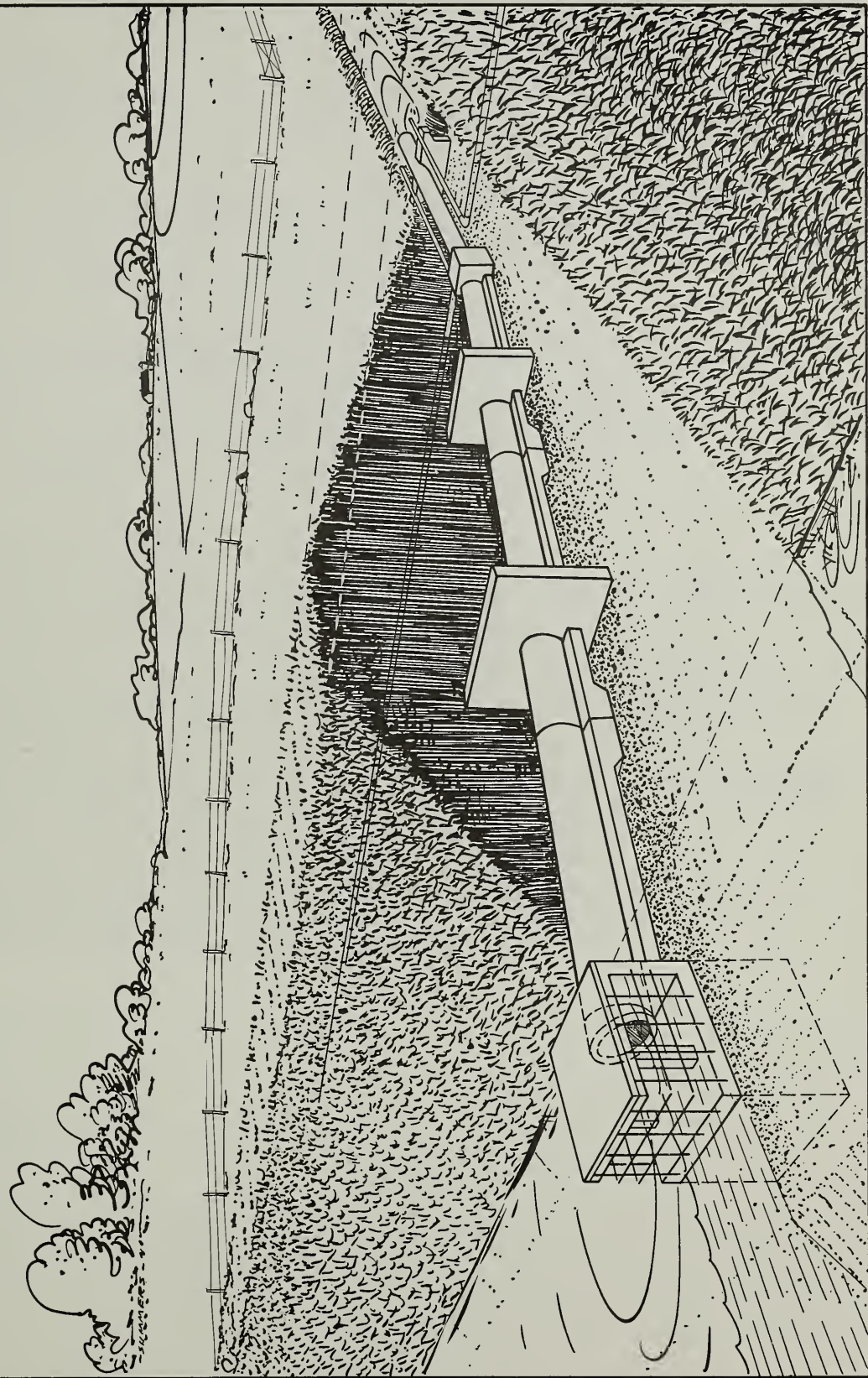


Monolithic drop-inlet on roadway and conservation pool with recreation and wildlife.





Drop-inlet with chute spillway.



Reinforced concrete pipe with hooded inlet.



Where borrow material for structures is obtained in the sediment basin (permanent pool area), the side slopes thus prepared at water elevation will be made no flatter than 3 to 1 to discourage growth of aquatic vegetation in shallow water and thereby reduce mosquito production. A toe drain system will be used in the multi-purpose and most of the other retarding structures to stabilize the earthfill slopes and prevent seepy areas that harbor mosquito production.

The approximate locations of the various types of structures are shown on the project map. Tables 2 and 3 set forth further data pertaining to costs, construction quantities, and design features of the various structural measures.

Facilities for Incidental Recreation: The City of Creston will provide public access and recreation facilities at site M-1. These will consist of sanitary facilities, water supply, and parking, as well as facilities for picnicking and boat launching. All facilities will comply with State and local public health requirements.

Relocation Payments

Structure M-1 and land being purchased adjacent to this site will result in the relocation of five families.

Relocation payments are included for five farming operations. Fifteen people are residing on these farms at the present time.

Three farming operations will lose all but a few acres of their farms. Two of these families will discontinue their operations and the third family will move to another location.

Two other farms will lose approximately one-half and one-third of their land. Both of these families will continue their operations by renting additional land.

EXPLANATION OF INSTALLATION COSTS

The project installation costs, as used in this work plan, include all costs to P.L. 566 and other funds, in cash or its equivalent, for installing all works of improvement for the project purposes of watershed protection, flood prevention, and for non-agricultural water management, which includes the municipal water supply.

The cost of installing land treatment measures includes all P.L. 566 and other costs for applying those measures and for technical assistance for their planning, layout, and installation. The costs also include costs to the farmers, cost sharing from going agricultural programs, and technical assistance from the State Cooperative Forest Management, P.L. 46, and P.L. 566 funds. The estimated cost of installing the land treatment measures is \$797,530. This is divided into \$17,590 from P.L. 566 funds and \$779,940 from other funds (Table 1).

The total cost of installing the forest land treatment measures is estimated to be \$9,300. Technical assistance to landowners for their installation will cost \$3,800 and will be provided under the P.L. 566 Program (\$3,200) and the Iowa Conservation Commission, Forestry Section (\$600). The installation costs to forest-land owners is \$5,500. It is expected that cost sharing from the Agricultural Conservation Program will be available to qualified landowners.

Costs of the forest land treatment measures are based on current costs of supervision, labor, equipment, and materials necessary to accomplish the specific measures.

Costs of technical assistance for the installation and promotion of the forest land treatment measures are based on actual expenditures and accomplishments of the Iowa Conservation Commission, Forestry Section. An analysis of costs against accomplishments was made for each measure to determine unit costs for technical assistance.

Construction costs of the structural measures and the municipal and industrial water supply include all contract costs for their installation. A contingency cost was added to the engineer's cost estimate to provide for unforeseeable cost increases during construction. Based upon experience to date in similar watershed work, the contingency cost was estimated to be 12 percent of the engineer's estimate.

The construction costs of mitigation measures to replace cover for wildlife have been included in the construction costs of the structural measures as indicated in Table 2. The estimated construction cost of the mitigation measures is \$13,100.

The total construction costs are estimated to be \$1,770,870 (Table 1). Of this amount, \$1,140,910 will be provided from P.L. 566 funds and \$629,960 from other or local funds.

Engineering services costs include the direct costs of engineers and other technicians for surveys, investigations, design, and preparation of plans and specifications for structural measures. The total engineering services cost for the structural measures and the municipal water supply storage are estimated to be \$260,300 (Table 1). P.L. 566 funds will bear \$198,970 and other or local funds \$61,330. The latter amount is the estimated engineering services costs for the municipal water supply.

The total estimated costs of relocation payments for this watershed are \$47,500. Paragraph 2 in the work plan agreement lists the percentages that each agency will assume of these payments. The Service will assume the first \$25,000 for these costs which occur prior to July 1, 1972. After this time they will be cost-shared by the percentages listed in the agreement.

Land rights costs include all expenditures made in acquiring land, easements, and rights-of-way or their value as estimated by the local sponsoring organization with concurrence by the Service. These costs have a value of \$589,680 and will be provided from local funds. Of this amount, \$5,650 is for land rights costs for mitigation measures.

Project administration costs are P.L. 566 and other or local administrative costs associated with the installation of structural measures including the cost of contract administration, review of engineering plans prepared by others, government representatives, construction surveys, and necessary inspection service during construction to insure that structural measures are installed in accordance with plans and specifications. These costs have been assigned to P.L. 566 funds and local funds in the estimated amounts that the Service and sponsors will incur in the installation of structural measures. Relocation assistance advisory services is included as a project administration cost. The total estimated project administration costs are \$224,910 and are assigned \$198,070 to P.L. 566 funds and \$26,840 to local funds (Table 1).

The "Use of Facilities Method" for cost allocation, as set forth in the Economics Guide for Watershed Protection and Flood Prevention, Soil Conservation Service, was used to determine the costs to be assigned to flood prevention and those to be assigned to municipal and industrial water for multiple-purpose structure M-1. The storage capacity of 8,000 acre-feet of water that is provided for water supply compared with 8,883 acre-feet of storage for flood prevention gave an allocation of 47.4 percent for municipal and industrial water supply and 52.6 percent for flood prevention. Therefore, the construction costs and engineering services costs of structure M-1 have been allocated to flood prevention and water supply in those ratios.

The total construction cost of structure M-1 is \$485,150, and includes the drawdown pipe and gate and mitigation measures. The City of Creston will share \$229,960 in the construction cost of structure M-1, and the Service \$255,190.

The total engineering services costs for structure M-1 are \$45,000. Of this, 47.4 percent, or \$21,330 is allocated to municipal water supply and will be paid for by the City of Creston. The remaining 52.6 percent or \$23,670 is allocated to flood prevention and will be paid for by the Service.

The total installation costs of all structural measures and the municipal and industrial water supply are \$2,893,260 (Table 1). This is divided into \$1,558,233 cost to the Service and \$1,335,027 cost to local funds.

The installation costs of an intake structure, pumping plant, and raw water-line for municipal water supply are specific costs for water supply and will be paid for by the City of Creston. The estimated cost is \$450,000.

The annual installation costs are \$156,310, the annual operation, maintenance and replacement costs are \$8,760 for a total annual cost of \$165,070 (Table 4)

An estimated schedule of Federal and non-Federal obligations, by fiscal years, for land treatment and structural measures is tabulated as follows:

Fiscal Year	: <u>Structural Measures</u> :		: <u>Land Treatment</u> :		Total
	566	Local	566	Local	
1	\$ 7,000	\$ 6,250	\$ 2,000	\$ 98,000	\$113,250
2	18,670	389,390	2,000	98,000	508,060
3	332,920	396,180	2,000	108,000	839,100
4	275,000	470,000	3,000	120,000	868,000
5	275,000	20,000	3,500	125,000	423,500
6	250,000	20,000	3,000	120,000	393,000
7	250,000	15,330	1,500	95,000	361,830
8	149,643	17,877	590	15,940	184,050
TOTAL	\$1,558,233	\$1,335,027	\$ 17,590	\$779,940	\$3,690,790

EFFECTS OF WORKS OF IMPROVEMENT

The project will enhance the community's economic viability by (1) increasing the stability of family farms through more efficient operations, reduced costs, and increased net returns; (2) providing the opportunity to take marginal land out of production, reducing the hazard of too much water on benefited areas, and reduction of wastage of scarce water; (3) providing a potential for the development of on-farm income producing recreation in connection with project structural measures; and (4) encouraging on-farm consumption of crops which show a tendency for increased production with the project. The project will also reduce public expenditures for road repairs and aid in stabilizing the tax base of local units of government.

Effects of Land Treatment Measures

The planned land treatment measures will effectively reduce sheet erosion on cropland and pastureland. The present rate of 3.4 tons per acre per year averaged for the entire upland area, will be reduced to 2.8 tons per acre per year. This is an 18 percent reduction in sheet erosion.

With the planned land treatment measures installed, 43,910 acres, or 88 percent of the watershed land will be adequately protected from sheet erosion and the accompanying damage. Some of the remaining 6,120 acres, or 12 percent of the land will be partially protected by conservation measures.

The various types of existing and planned terraces will retard the runoff of waterways and land treatment gully control structures will reduce gully erosion and facilitate farming operations by eliminating existing non-crossable gullies.

The proposed forest land treatment measures will improve the hydrologic condition of the forest land. This will retard surface runoff and effect a reduction in sediment. In addition, proper management, protection from grazing and continued fire protection will increase the productivity of the forest land of the watershed.

The proposed watershed project will have a marked beneficial effect on certain fish and wildlife resources, both real and potential, throughout much of the watershed. The sport fishery stands to realize the greatest gain. Benefits of waterfowl and aquatic fur animals will accrue due to the increase in surface acreage of ponded water, some of shallow depth, and some of depths up to 20 or 30 feet.

Effects of Structural Measures

Benefits from the project have far-reaching effects on the inhabitants, land, and facilities in the watershed.

A total of about 33,400 acres (67 percent of the watershed) will have the runoff and flood producing potential reduced by floodwater retarding structures to a fraction of that without the project. This amount of control will reduce flood flows, augment base flows, reduce the sediment damage, and reduce maintenance costs on State and County roads within and downstream of the project.

Floodwater damage to crops and pasture in the evaluated bottomland area will be reduced 78 percent. These benefits will accrue to 54 farms; these farms will also realize land enhancement benefits on existing croplands, since more intensive use can be safely practiced. The total area damaged by a 5-year frequency flood will be reduced from 1,492 acres to 466 acres. The average annual area flooded will be reduced from 1,104 acres to 246 acres.

With the project installed, farmers will be able to follow a higher level of management such as use of optimum amounts of fertilizer, more timely operations, etc. The use of this bottomland for cropping will permit less intensive cropping on the more erodible upland areas. Reduction of flooding will permit changed land use on 430 acres of the bottomland. More intensive use of land will occur on 1,490 acres of the bottomland floodplain.

Union County will realize benefits at seven bridge sites through reduced future costs of replacement. These bridges lie downstream from the proposed detention type structures. When the present bridges are in need of replacement, the resulting reduced peak flows will permit installation of smaller and less costly culverts that require less maintenance.

Union County will also realize benefits by reduction of damages to roads at 19 additional locations in the watershed.

Benefits will be realized at six locations to railroads located within the watershed.

Some reduction of flood flows on bottomland areas of the Thompson River will result from the project. About 13.2 percent of the total drainage area of the Thompson River above its confluence with Twelve Mile Creek, will be controlled by the project. Damage reduction benefits were evaluated for 23.5 miles downstream from this point.

Of the 346 farms in the watershed, benefits from gully erosion damage reduction will accrue to 3,255 acres on 128 farms.

A total of 2,272 acres of bottomland within the watershed and 8,850 acres in the downstream Thompson River flood plain will receive benefits from reduction of floodwater damage. These floodplain areas, together with the area benefited from a reduction in gully erosion totals to be 14,377 acres.

The sediment storage pools of 10 grade stabilization structures, and 22 floodwater retarding structures could have local private recreational use for a portion of the life of the project. These areas will also provide desirable waterfowl and fish habitat.

Many farmers have indicated that they will secure fish for stocking from various sources that are available. It is expected that some of the ponds will be fenced by farmers and that wildlife food and cover plantings be established near ponds and in odd corners. These ponds will provide farm families and others with recreational opportunities such as fishing, swimming, boating, picnicking, hunting, etc. However, no monetary value of these incidental recreational benefits has been estimated.

The Sponsoring Local Organizations are aware that incidental recreational use may require attention and consideration for installing sanitary facilities at some of these sites. If the use becomes so concentrated at any site that toilet facilities are required for protection of health, they will either arrange to provide such facilities or restrict the use of the water pool areas. It is not intended that drinking water be available at any of these sites.

Structure M-1 is designed as a multiple-purpose structure with storage for flood runoff and for municipal and industrial water. Creston has a present population of 8,234 people who will be served by the municipal and industrial water supply. With the addition of the municipal water supply in this structure, Creston will have an adequate supply to allow present industry to expand, to attract new industry and to serve future domestic uses. With the present water supply, Creston has to restrict both domestic and industrial use during water shortages. Because of the present water shortages, new industry has been discouraged from locating in Creston. The increased economic activity with an adequate water supply, will enhance the well being of local residents and create additional jobs for presently underemployed and unemployed people in this area. The water is of adequate quality to be processed through the present water treatment plant operated by the water board. The consulting engineer's recommendation of storing a three year water supply to provide for periods of drought, and to assure a dependable supply, was followed.

The water area of structure M-1 and about 747 acres of land surrounding the pool will be made available by the City of Creston for some recreational use. Public access and a minimum number of recreation facilities such as parking, boat ramp, water, and toilets, will be made available at the site.

The main recreation season for fishing and boating is about 100 days. The peak daily use over weekends and holidays may vary from 150 to 700 visitor days. Total annual use for the season is estimated to be 31,500 days. Estimated value per day is 80 cents and 15 cents per day for installation, operation, maintenance and replacement of the recreation facilities.

Secondary benefits will accrue within the immediate zone of influence of the project. They include (1) the transporting, processing, and marketing of goods and services that produce the primary benefits and (2) the supplying of additional materials and services required to make possible the increased net returns which result from the installation of the project. These benefits accrue primarily to processors and merchants providing services to farmers.

Effects on Fish and Wildlife Resources

The project has potential to be both beneficial and detrimental to wildlife habitat. Certain game species, such as waterfowl, will enjoy an increase in habitat while certain groups and species will temporarily lose some habitat. For example, some wooded terrestrial wildlife habitat of value to upland game and deer will be destroyed in the permanent pools of floodwater retarding reservoirs. These species will suffer a temporary setback during the period in which replacement of cover is being established.

The planting of 155 acres to trees, shrubs and herbaceous cover in small plots and surrounding structure M-1 should adequately compensate for losses of nesting and other cover inundated by the structures.

The 72 acres of wildlife habitat plantings planned on farms with conservation plans will further enhance wildlife production. The 136 acres of planned woodland improvements will likewise benefit wildlife.

The numerous grade stabilization structures will create small aquatic niches useful to resident game and possibly be attractive to nesting wood ducks. The larger detention structures will create a lake-like complex, previously unknown in the watershed. Some of this ponded water will attract waterfowl during migration, especially the larger areas. The dispersal of the total of 33 water impounding structures should attract large quantities of waterfowl shorebirds, coots, rails, herons, and many others during those seasons.

Thus, in total consideration of all values, a better ecological balance of wildlife habitat and population will likely result from the project installation.

PROJECT BENEFITS

The average annual evaluated floodwater damage to crops, pasture, other agricultural and non-agricultural damages of \$52,930 will be reduced to \$7,890, a \$45,040 floodwater reduction benefit (Table 5).

The average annual evaluated damage from sediment deposits in the watershed of \$1,460 will be reduced to \$60, a \$1,400 sediment damage reduction benefit.

The annual evaluated gully erosion damage to land of \$28,460 will be reduced to \$830 a benefit of \$27,630. Damages to other agriculture facilities are evaluated to be \$820 and will be reduced to \$40 for a benefit of \$780. Non-agricultural damages are evaluated to be \$210 and will be reduced to \$10 for a benefit of \$200 (Table 5).

Indirect damages of \$8,380 which accompany the direct damages, will be reduced to \$260 giving an annual benefit of \$8,120 (Table 5).

Incidental recreation benefits accruing to the project after deducting costs for installation, operation, maintenance and replacement of recreation facilities were estimated to be \$20,500 annually (Table 6).

The annual municipal water supply benefits accruing to the City of Creston are estimated to be \$58,800 (Table 6).

Changed land use benefits that will accrue annually on protected bottomland areas are \$10,240. Annual benefits from more intensive use of bottomlands protected from flooding are \$10,760, giving a total annual land enhancement benefit of \$21,000 (Table 6).

Downstream floodwater damage reduction benefits allocated to Twelve Mile Creek Watershed are estimated to be \$13,910.

The significance of all of the above benefits is apparent in the immediate zone of influence on the local communities. However, the local effects of the project and the resulting benefits suggested consideration of secondary benefits from only the local viewpoint. Secondary benefits from a national viewpoint were not considered pertinent to the economic evaluation. The average annual value of local secondary benefits is \$6,210 (Table 6).

The total of the above estimated primary and secondary benefits from the project are \$203,590 annually (Table 6).

COMPARISON OF BENEFITS AND COSTS

The annual installation costs of the structural measures are \$156,310. The annual operation, maintenance and replacement costs are \$8,760 of which \$30 is for replacement of corrugated metal pipe spillways in three structures and \$4,000 is for the intake structure, pumping plant and raw water line to Creston (Table 4).

The average annual primary flood prevention benefits from the structural measures in the project, excluding local secondary benefits, are \$197,380; this compared with the average annual cost of \$165,070 gives a benefit-cost ratio of 1.2 to 1.0.

The average annual primary and local secondary flood prevention benefits from the structural measures in the project are \$203,590; this compared with the average annual cost of \$165,070 gives a benefit-cost ratio of 1.23 to 1.0 (Table 6).

PROJECT INSTALLATION

This project will be installed during an eight year project installation period. The local sponsoring organizations and the Service will coordinate the installation of the structural measures in the project with the planning and application of land treatment measures on the individual farms. The planning and application of land treatment measures should progress as rapidly as resources permit and should be of such intensity and scope as to meet the hydrologic and sediment design criteria of the structural measures.

Land Treatment Measures

An intensive program of education and demonstrations, along with group planning meetings and direct assistance to farmers, will be used to facilitate the installation of the needed treatment measures.

The District governing bodies will schedule meetings to facilitate carrying out the planned land treatment program, set priorities of farmers to be assisted, make periodic checks on completed measures and maintenance needs, and otherwise assist to further the land treatment phase of the watershed project. Details of each individual landowner's portion of the planned land treatment measures will be defined in the cooperator's conservation plan.

Land treatment measures will be installed by the individual farmer or small groups of farmers working together. The current Agricultural Conservation Program will be utilized as may be available for those practices eligible for cost-sharing assistance. Service technicians working with the District will assist with the planning and application of the land treatment measures.

The current land treatment program is being planned and applied by the landowners and District with technical assistance provided by the Service under the authority of Public Law 46. In order that the planned land treatment measures may be installed during the project period, an acceleration of the present rate of application will be required. Additional technical assistance for this purpose will be made available by the Service from P.L. 566 funds.

The forest land treatment measures will be installed by the landowners with technical assistance provided by the State Conservation Commission, Forestry Section, in cooperation with the U. S. Forest Service.

Additional land treatment measures will more completely protect the remaining watershed lands and it is expected that these needed additional measures will be installed by landowners in the years following the project installation period. It is expected that normal going program assistance will be available for this installation.

Structural Measures

All structural measures will be installed by contract. The City of Creston will administer and award contracts for structure M-1. The Service is requested and agrees to contract for and install the remaining structures.

Engineering services for structure M-1 will be contracted for by the City of Creston. An "Agreement for Engineering Services" will be executed by the Service and the City of Creston. This agreement will set forth the engineering services to be accomplished, the estimated costs of these services, and payments and/or reimbursements by each party to meet the cost-sharing requirements, etc. Engineering services for all other structures will be provided or contracted for by the Service.

Project administration will be provided by the Service and by the Sponsoring Local Organizations, each, as required for the satisfactory completion of the work.

Eleven construction units have been established in order to provide maximum flexibility in establishing a sequence for installing the structural measures (Table 7). Land rights for all structural measures of any one construction unit will be obtained before a project agreement is executed for the installation of any of the structural measures in that construction unit.

The Sponsoring Local Organizations will acquire or provide assurance that landowners or water users have acquired such water rights as the State law may require for the installation and operation of works of improvement.

These easements are renewable and will be renewed if the State Conservation Commission feels more time is needed to accomplish the purpose for which they were established.

The District will acquire land rights for structural measures, other than for mitigation measures and for structure M-1. Should the District not be able to acquire such land rights, the County has power of eminent domain and will use this authority to acquire those land rights as need be.

For the wildlife mitigation measures, the State Conservation Commission will acquire land rights by 15 year term easements such as are used in its farm game habitat program.

The City of Creston will acquire land rights for structure M-1 by purchase in fee simple title. The City has and will use its power of eminent domain, if need be, to acquire land rights.

The City of Creston will be the Sponsor that will provide personally or by first class mail, notice of displacement and necessary forms to each displaced person or farm. They will assist in filing applications. They will also review and process grievances in connection with displacements and see that payments are made.

The Service will assist the local Sponsors in all phases listed in the above paragraph.

Relocation assistance advisory services will be provided and all costs borne by the City of Creston. This includes the following:

- (1) Determine need of displaced persons for relocation assistance.
- (2) Provide current information on the availability, prices, and rentals, of decent, safe and sanitary sale and rental housing.
- (3) Assure that within a reasonable period of time prior to replacement, replacement dwellings will be available.
- (4) Assist a displaced person in obtaining and becoming established in a suitable replacement location.
- (5) Supply information concerning housing programs, disaster loan programs, and other Federal or State programs offering assistance to displaced persons.
- (6) Provide other advisory services in order to minimize hardships of displaced persons in adjusting to relocation.
- (7) Advise displaced persons to notify the displacing agency before moving.

- (8) Provide brochure, outlining benefits to which they are entitled, to persons from whom the land will be acquired.

All persons displaced by the project will receive a 90 day notice before they must move. The sponsors have determined that decent, safe and sanitary replacement housing will be available when needed.

After the required land rights in a construction unit have been acquired and certification made for the adequacy of land treatments, a "Project Agreement for Construction of Structural Measures" will be executed for each contract unit of work prior to the issuance of invitations to bid. This agreement for structure M-1 will be executed by the Service, the City of Creston, Union County, and Union District. For all other structures the agreement(s) will be executed by the Service, Union District, and Union County. Each agreement will set forth details pertaining to the responsibilities of each party.

Union County will close county roads or modify them as necessary for the installation of structures M-1, D-59, D-62A and 72-2. This modification includes replacing the culvert under old U. S. Highway 34 that will be submerged by the permanent pool of structure D-62A when this replacement may be required because of sediment accumulation.

All private land adjacent to the City-owned land surrounding structure M-1 and the water area will be zoned and regulated by Union County.

The quality of water in the reservoir of M-1 will be adequate as a source of municipal water. Its contributing drainage area has the same general land use and soil types as does Summit Lake and Green Valley Lake which have provided water for Creston during the past years. No toxic or other wastes from industries or municipalities are deposited in the drainage area.

Public access to the water area of structure M-1 will be made available so as to realize the incidental recreation use of the area.

The City of Creston will provide such sanitary facilities as may be required by State law to prevent any unsanitary conditions as a result of disposing of human or non-human waste.

The State Conservation Commission will develop plans for the planting of mitigating wildlife food and cover in the 155 acres of small plots and city-owned land in the watershed. The State Conservation Commission has requested and it is agreed that the Service will award and administer contracts for the installation of these plantings.

FINANCING PROJECT INSTALLATION

Federal assistance for installing the works of improvement on the non-Federal land, as described in this work plan, will be provided under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress, 68 Stat. 666, as amended).

The Sponsoring Local Organizations have adequate funds available to be used for organizational expenses.

Individual landowners will assume the cost of installing land treatment measures with such cost-sharing assistance as may be available under the provisions of the Rural Environmental Agriculture Program (REAP) or any other going agricultural cost-sharing programs.

Technical assistance to landowners for installing land treatment measures will be provided by the Service from P.L. 566 and P.L. 46 funds and by the Districts from State appropriated funds.

Technical assistance to landowners for the installation of forestry measures will be provided under the P.L. 566 program and the Iowa Conservation Commission, Forestry Section. The landowners will bear the costs of installing forestry measures. It is expected that the REAP cost sharing will be available to qualified landowners for installing these measures.

The Service will finance its share of construction costs, engineering services costs, and project administration costs from P.L. 566 funds.

Facilities and funds are available to the Sponsoring Local Organizations for construction costs, engineering services costs, relocation payments, and project administration costs incurred by them in the installation of this project.

The City of Creston will finance the land rights costs and its share of structure M-1 for the water supply purpose and all related engineering services costs and project administration costs and costs of an intake structure, pumping plant, and raw water line to Creston by borrowing from the Farmers Home Administration under the loan authority of P.L. 566.

Negotiations for an FHA loan have started. The amount of an FHA loan needed by the City of Creston is \$1,200,350. This is divided as follows:

1. Land rights purchase, Site M-1 (includes flowage easements)	\$475,000
2. Land surveys, legal fees, etc.	9,500
3. Construction Cost, Site M-1	229,960
4. Engineering Services, Site M-1	21,330
5. Project administration, Site M-1	14,560

6. Intake structure, pumping plant and raw water line	400,000
7. Engineering Services	40,000
8. Land rights	<u>10,000</u>
	\$1,200,350

Land rights for structural measures, other than structure M-1, will be donated by the concerned landowners or otherwise acquired by Union District and Union County with funds that will be available through tax levy or that will be donated.

The State Conservation Commission will obtain land rights for 10 to 15 year or longer term easements for the wildlife planting plots. These easements are expected to be donated by interested landowners.

The Sponsoring Local Organizations have analyzed their financial needs in consideration of the scheduled installation of the works of improvement so that funds will be available when needed through donations, cash reserves, tax or assessment levies, or credit.

This work plan does not constitute a financial document to serve as a basis for the obligation of Federal funds. Financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the appropriation of funds for this purpose. The estimated amounts of funds required from P.L. 566 and other funds is shown in Tables 1 and 2 in the previous section, "Explanation of Installation Costs".

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

Land treatment measures will be maintained by the individual landowners and/or operators as prescribed in the conservation plans developed between the farmers and the Districts. Technical assistance will be made available through the Districts by the Service.

The forest land treatment measures will be maintained by the landowners with technical assistance furnished by the State Conservation Commission, Forestry Section, in cooperation with the U. S. Forest Service under the going Cooperative Forestry Program.

Structural Measures

Structural measures and the municipal and water supply storage included in the project are planned and designed to serve project objectives. The total benefits to be derived from the installation of structural measures cannot usually be realized unless the measures are operated and maintained in such a manner that they will serve the full purpose for which they were installed. The program for operation and maintenance consists of:

1. An agreed-to plan which will provide adequate and sound arrangements for proper operation, timely inspection and prompt and appropriate performance of needed maintenance; financing the costs of operation and maintenance; and the maintaining of records reflecting the actions required and taken.
2. The carrying out of the provisions of the agreed-to plan in a manner consistent with the spirit, intent, and purpose of the plan and project.

The responsibility for operation and maintenance of the structural measures, except for structure M-1, will be assumed by the Union District and Union County. An agreement has been executed between the District and the County whereby, in accordance with Iowa law, the County will levy taxes as needed upon the agricultural lands in the County, not to exceed one-quarter mill per year, the proceeds of which will be used for the operation, repair, alteration, and maintenance of the structural measures. The revenue from this tax is estimated to be adequate for this purpose.

The City of Creston will provide for periodic pickup of refuse from the picnic, boating, and other access areas of site M-1 to prevent and control noxious insects, rats, field rodents, and other small animals. Brush and weeds along paths, trails, roadways, and other areas of frequent use by visitors will be removed to minimize likelihood of tick infestation. Periodic removal of aquatic vegetation, algae, knats, and floatage from shallow, marginal portions of the reservoir may be necessary.

Structure M-1 will be maintained jointly by the Union District, Union County, and the City of Creston. Funds required for the District's maintenance requirements will be acquired by Union County as indicated above. The City will provide funds for their share of maintenance from water revenue.

The Service will participate in operation and maintenance only to the extent of (1) furnishing technical assistance to aid in inspections and (2) furnishing technical design information necessary for operation and maintenance. When operation and maintenance is not being properly carried out, as found from inspections by the Service, the matter will be brought to the attention of the Local Sponsoring Organizations.

Operation and maintenance agreements setting forth all details in connection with responsibilities for operation and maintenance of the structural measures will be executed prior to the signing of land rights and/or project agreements for construction of the measures. This agreement(s) will be executed by the Service, Union District, and Union County for all structural measures except structure M-1.

For structure M-1, the agreement will be executed by the Service, Union District, Union County, and the City of Creston.

The State Conservation Commission will provide maintenance and upkeep for all of the mitigation plantings for replacing the wildlife habitat losses.

Inspection of the structural measures will be made annually by the local Sponsoring Organizations and the Service for three years after the structures are completed. After the third year, the annual inspections will be made by the Local Sponsors. Additional inspections will be carried out following a severe storm or any other unusual condition that might adversely affect the structural measures. These inspections will be made to determine maintenance needs and will include the following determinations:

1. Rodent damage to earth fills; may need refilling, rodent control, etc.
2. Condition of emergency spillways and earth fills including vegetative cover and its needed improvement; may need filling of rills, reseeding or sodding, prevention of grazing, etc.
3. Needs for removal and disposal of debris in the sediment and temporary pools.
4. Condition of the principal spillway; may need calking, replacing sections of pipe, adding riprap, etc.
5. It is anticipated that corrugated metal pipes used for principal spillways in structures 62-4, 67 and 73 will need to be replaced in about 50 years.
6. The quality of water in the sediment pools will periodically be considered by the Sponsors for adequacy of meeting health standards for such contact sports as swimming, water skiing, etc. Primary concern in this regard will be given to barn-yard drainage and the use of herbicides, insecticides, etc.

A report of the annual inspection findings will be provided to the Service. When operation and maintenance is not being properly carried out, the matter will be brought to the attention of the Sponsoring Local Organizations.

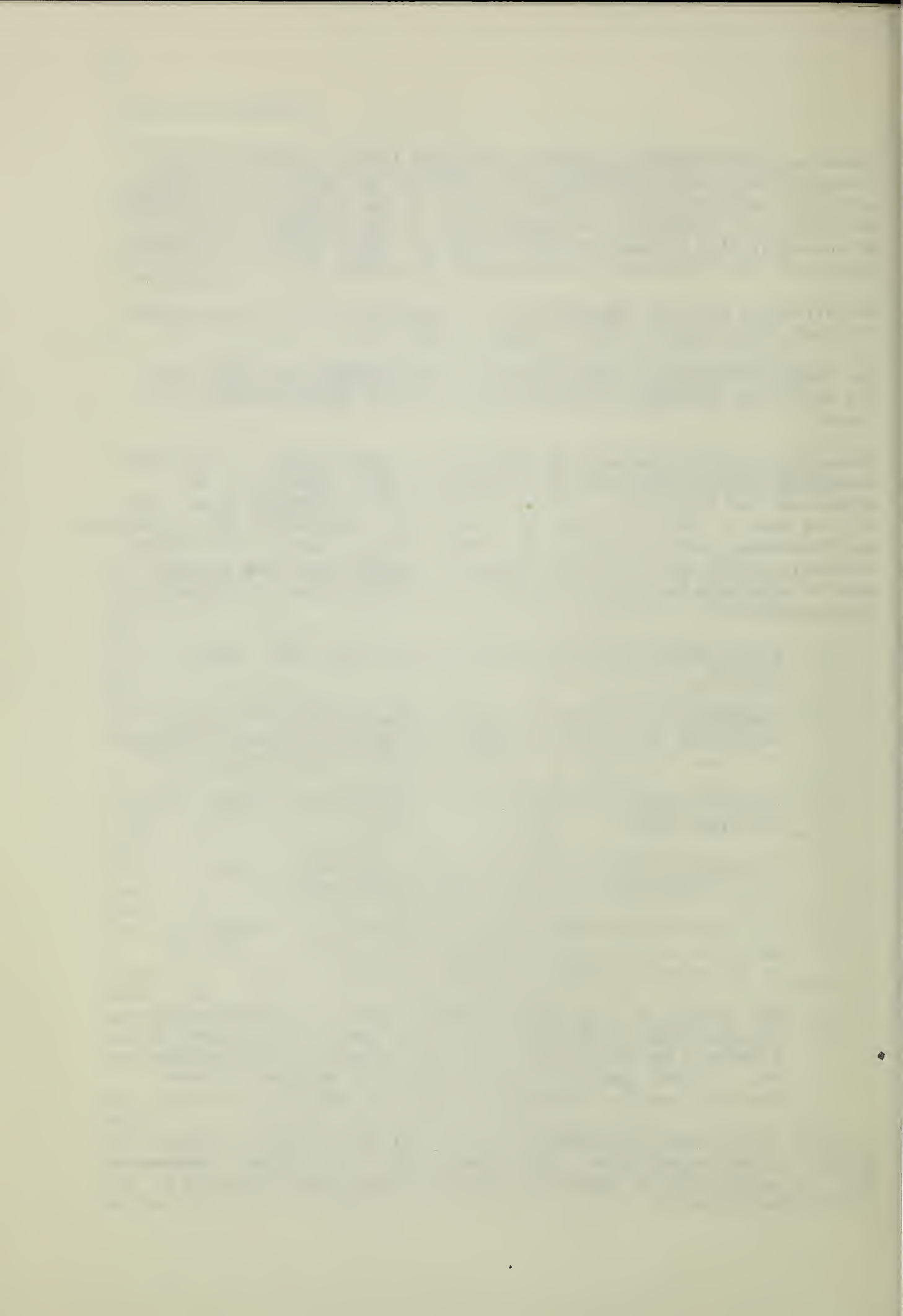


TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Twelve Mile Creek Watershed, Iowa

Installation Cost	:	:	:	Estimated Cost		
Item	:	:	Number	(Dollars) 1/		
	:	Unit	Non-Fed.	P.L. 566	Other	
	:	:	Land	Non-Federal Land	Total	
(1)		(2)	(3)	(4)	(5)	(6)
<u>LAND TREATMENT</u>						
Soil Conservation Service						
Cropland	Ac.	5,943			388,830	388,830
Pastureland	Ac.	6,794			340,060	340,060
Technical Assistance				14,390	44,950	59,340
SCS Subtotal				14,390	773,840	788,230
<hr/>						
Forest Service						
Forest Land	Ac.	818			5,500	5,500
Technical Assistance				3,200	600	3,800
FS Subtotal				3,200	6,100	9,300
<hr/>						
TOTAL LAND TREATMENT				17,590	779,940	797,530



TABLE 1 - ESTIMATED PROJECT INSTALLATION COST (Cont'd)

Twelve Mile Creek Watershed, Iowa

Installation Cost Item	:	:	:	Estimated Cost	
	:	:	Number	(Dollars) 1/	
	:	Unit	Non-Fed.	P.L. 566	Other
	:	:	Land	Non-Federal Land	Total
(1)	(2)	(3)	(4)	(5)	(6)
TOTAL LAND TREATMENT			17,590	779,940	797,530
<hr/>					
<u>STRUCTURAL MEASURES</u>					
<u>Construction</u>					
Soil Conservation Service					
Gr. Stab. Str.	No.	11	150,850	-	150,850
F.W. Retarding Str.	No.	22	734,870	-	734,870
Multi-Purpose Str.					
M-1	No.	1	255,190	229,960	485,150
Intake Str., Pumping					
Plant, & Raw Waterline	No.	1		400,000	400,000
Subtotal - Construction			1,140,910	2/ 629,960	3/ 1,770,870
<hr/>					
<u>Engineering Services</u>					
Soil Conservation Service			198,970	61,330	260,300
Subtotal - Engineering			198,970	61,330	260,300
<hr/>					
<u>Relocation Payments</u>					
Soil Conservation Service			20,283	27,217	47,500
Subtotal - Relocation Payments			20,283	27,217	47,500
<hr/>					
<u>Project Administration</u>					
Soil Conservation Service					
Relocation Assist Adv. Svcs.				3,560	3,560
Construction Inspection			158,490	6,200	164,690
Other			39,580	17,080	56,660
Subtotal - Administration			198,070	26,840	224,910
<hr/>					
<u>Other Costs</u>					
Land Rights				589,680	4/ 589,680
Subtotal - Other				589,680	589,680
TOTAL STRUCTURAL MEASURES			1,558,233	1,335,027	2,893,260
T O T A L P R O J E C T			1,575,823	2,114,967	3,690,790
<hr/>					
SUMMARY					
Subtotal SCS			1,572,623	2,108,867	3,681,490
Subtotal FS			3,200	6,100	9,300
T O T A L P R O J E C T			1,575,823	2,114,967	3,690,790

1/ Price Base: 1971

2/ Includes \$11,420 of Construction Cost for Mitigation Measures.

3/ Includes \$ 1,680 of Construction Cost for Mitigation Measures.

4/ Includes \$ 5,650 for land rights for mitigation measures.



TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT

Twelve Mile Creek Watershed, Iowa

Measures	:	Unit	:	Applied to Date	:	Total
	:		:		:	Cost
	:		:	Amount	:	Dollars <u>1/</u>
(1)		(2)		(3)		(4)
<u>Soil Conservation Service</u>						
Land Treatment Measures						
Contour Farming		Ac.		10,470		20,940
Grassed Waterway		Ac.		541		162,300
Terraces, Gradient		Mi.		69		25,490
Terraces, Parallel		Mi.		8		10,200
Diversions		Mi.		22		22,200
Grade Stabilization Structure		No.		27		54,000
Farm Ponds		No.		178		160,200
Pasture Planting		Ac.		3,479		173,950
Wildlife Habitat Development		Ac.		208		12,480
Tile Drains		Mi.		69		103,650
Farm Plans						
Conservation Plans		No.		150		xx
Revised Plans		No.		25		xx
Cooperators		No.		199		xx
<u>Forest Service</u>						
Tree Planting (open land)		Ac.		15		370
Grazing Control		Ac.		587 <u>2/</u>		2,350
Fire Control		Ac.		4,795		4,800
<hr/>						
TOTAL		xx		5,397 <u>3/</u>		752,930

1/ Price Base:2/ Includes approximately 500 acres of a single ownership entered under the Forest and Fruit Trees Act for tax-break purposes.3/ Ten year period (1958-1967).

Date: November 1971

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO

Twelve Mile Creek Watershed, Iowa

(Dollars) $\frac{1}{\text{}}$

Item	: Installation Cost P. L. 566 Funds :				Installation Cost - Other Funds				: Total	
	: :		: Reloca-:		: :		: Reloca-:		: Installa-	
	: Construc-:	: Engi-:	: tion :	: Total :	: Construc-:	: Engi-:	: Land :	: tion :	: Total :	: tion :
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	: tion :	: neering:	: Payment	P.L.566	: tion :	: neering:	: Rights :	: Payments:	: Other :	: Cost :
Grade Stab. Structures										
62-4	10,080	2,020		12,100			700		700	12,800
62-5	22,400	4,480		26,880			1,390		1,390	28,270
67	9,860	1,970		11,830			650		650	12,480
68-1	12,750	2,530		15,280			1,000		1,000	16,280
68-2	15,770	3,140		18,910			1,300		1,300	20,210
71	11,200	2,240		13,440			1,950		1,950	15,390
72-1	14,300	2,840		17,140			2,600		2,600	19,740
72-2	12,380	2,440		14,820			1,900		1,900	16,720
73	11,420	2,280		13,700			1,700		1,700	15,400
74	8,850	1,770		10,620			50		50	10,670
77	21,840	4,370		26,210			1,180		1,180	27,390
Subtotal - Gr. Stab. Str.				150,850	30,080		14,420		14,420	195,350







FOOTNOTES - TABLE 2

Twelve Mile Creek Watershed, Iowa

- 1/ Price Base: 1971
- 2/ All structures listed in column 1, except 58, 62-4, 62-5, 67, 71, 73, 74 and 77 include construction and land rights costs for mitigation measures.
- 3/ Includes \$8,000 for replacement of culvert.
- 4/ Includes \$9,500 for land surveys, title search, etc., and \$4,400 for flowage easements.
- 5/ Includes cost of intake structure, pumping plant and raw water line to the water treatment plant at Creston. This is a specific cost to M & I Water and will be paid by the City of Creston.
- 6/ Relocation payments for displacements prior to July 1, 1972 will be shared as provided in P. L. 91-646 and in paragraph numbered 2 of the work plan agreement.



TABLE 2A - COST ALLOCATION AND COST SHARING SUMMARY

Twelve Mile Creek Watershed, Iowa
(Dollars) 1/

Item	COST ALLOCATION		COST SHARING							
	PURPOSE		P. L. 566 Funds						Other Funds	
	Flood : M & I : :Prevention: Water :	Total :	Flood : M & I : :Prevention: Water :	Total :	Flood : M & I : :Prevention: Water :	Total :	Flood : M & I : :Prevention: Water :	Total :		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	
33 Flood Prevention Structures	1,156,200	-	1,156,200	1,061,020	-	1,061,020	95,180	-	95,180	
1 Multi-Purpose Str.	558,680	503,470	1,062,150	289,523	9,620	299,143	269,157	493,850	763,007	
Intake Structure		450,000	450,000					450,000	450,000	
GRAND TOTAL	1,714,880	953,470	2,668,350	1,350,543	9,620 <u>2/</u>	1,360,163	364,337	943,850	1,308,187	

1/ Price Base - 1971

2/ Cost sharing is for relocation payments.

Date: November 1971

TABLE 3 - STRUCTURAL DATA

STRUCTURES WITH PLANNED STORAGE CAPACITY

Twelve Mile Creek Watershed, Iowa

Item	Unit	S T R U C T U R E N U M B E R										
		M-1	17	18	23	27	30	D35	35-2	36		
Class of Structure												
Drainage Area	Sq Mi	b	a	a	a	a	a	a	a	a		
Uncontrolled	Sq Mi	23.0	0.94	0.73	0.61	0.97	0.58	1.64	0.66	0.73		
Controlled	Sq Mi	23.0	0.94	0.73	0.61	0.97	0.58	1.64	0.66	0.73		
Curve No. (1-day) (AMC II)		1/										
Tc	Hr	79	79	79	79	79	79	79	79	79		
Elevation Top of Dam		11.5	0.48	0.28	0.33	0.47	0.46	1.00	0.41	0.42		
Elevation Crest Emergency Spillway	Ft	1190.0	1086.5	1080.4	1063.6	1067.4	1098.5	1099.2	1086.5	1098.5		
Elevation Crest High Stage Inlet	Ft	1186.0	1064.0	1078.0	1061.5	1065.0	1096.5	1096.5	1084.5	1096.0		
Maximum Height of Dam	Ft	1177.0	1054.0	1069.0	1054.0	1056.0	1088.0	1086.0	1076.0	1087.0		
Volume of Fill	Ft	51	30	33	34	29	34	31	29	30		
Total Capacity	Cu Yd	464,000	24,000	25,000	24,000	26,000	24,000	32,000	27,000	25,000		
Sediment Submerged 1st 50 years	Ac Ft	16,883.0	211.2	165.0	152.0	202.0	128.0	375.0	172.0	154.7		
Sediment Submerged 2nd 50 years	Ac Ft	1,231.0	44.9	46.3	31.2	38.6	26.0	100.7	36.1	36.3		
Sediment Aerated	Ac Ft	969.0	23.1	15.4	36.3	16.4	22.9	35.0	25.0	13.7		
Retarding	Ac Ft	250.0	10.9	11.2	7.9	9.4	7.3	28.8	8.9	8.8		
Municipal Water	Ac Ft	6,433.0	132.3	92.1	76.6	137.6	71.8	210.5	102.0	95.9		
Surface Area		8,000.0	-	-	-	-	-	-	-	-		
Sediment pool	Ac	270.0	10.6	8.0	8.8	10.3	6.4	16.8	8.7	7.7		
Municipal pool	Ac	633.0	-	-	-	-	-	-	-	-		
Retarding pool	Ac	874.0	18.8	15.2	15.2	22.2	12.3	36.0	17.8	15.5		
Principal Spillway												
Rainfall Volume (areal) (1 day)	In.	6.93	5.65	5.65	5.65	5.65	5.65	5.65	5.65	5.65		
Rainfall Volume (areal) (10 day)	In.	12.35	9.65	9.65	9.65	9.65	9.65	9.65	9.65	9.65		
Runoff Volume (10 day)	In.	7.33	5.08	5.08	9.08	9.08	9.08	9.08	9.08	9.08		
Capacity of High Stage (Max.)	cfs	396	67	71	34	71	69	67	32	66		
Frequency operation - Emer.Splwy.	%chance	2	4	4	4	4	4	4	4	4		
Size of Conduit	Dia..In.	48"	24"	24"	18"	24"	24"	24"	18"	24"		
Emergency Spillway - Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.		
Rainfall Volume (ESH)	In.	8.65	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3		
Runoff Volume (ESH)	In.	6.11	3.07	3.07	3.07	3.07	3.07	3.07	3.07	3.07		
Bottom Width	Ft	500	30	30	32	34	32	58	32	30		
Velocity of Flow (V _e)	Ft/Sec	1.0	0	2.4	0	0	1.6	3.5	0	2.1		
Slope of Exit Channel	Ft/Ft	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04		
Maximum water surface elevation	Ft	1186.2	1064.0	1078.3	1061.5	1065.0	1096.6	1097.2	1084.5	1096.3		
Freeboard												
Rainfall Volume (FH) (areal)	In.	15.1	7.75	7.75	7.75	7.75	7.75	7.75	7.75	7.75		
Runoff Volume (FH)	In.	12.31	5.27	5.27	5.27	5.27	5.27	5.27	5.27	5.27		
Maximum water surface elevation	Ft	1189.2	1066.5	1080.4	1063.6	1067.4	1098.5	1099.2	1086.5	1098.4		
Capacity Equivalents												
Sediment Volume	In.	1.99	1.58	1.86	2.32	1.25	1.82	1.88	1.98	1.50		
Retarding Volume	In.	5.23	2.65	2.35	2.36	2.66	2.33	2.41	2.88	2.45		

1/ For this structure design, structures upstream were ignored in flood routing, but were credited for sediment storage.

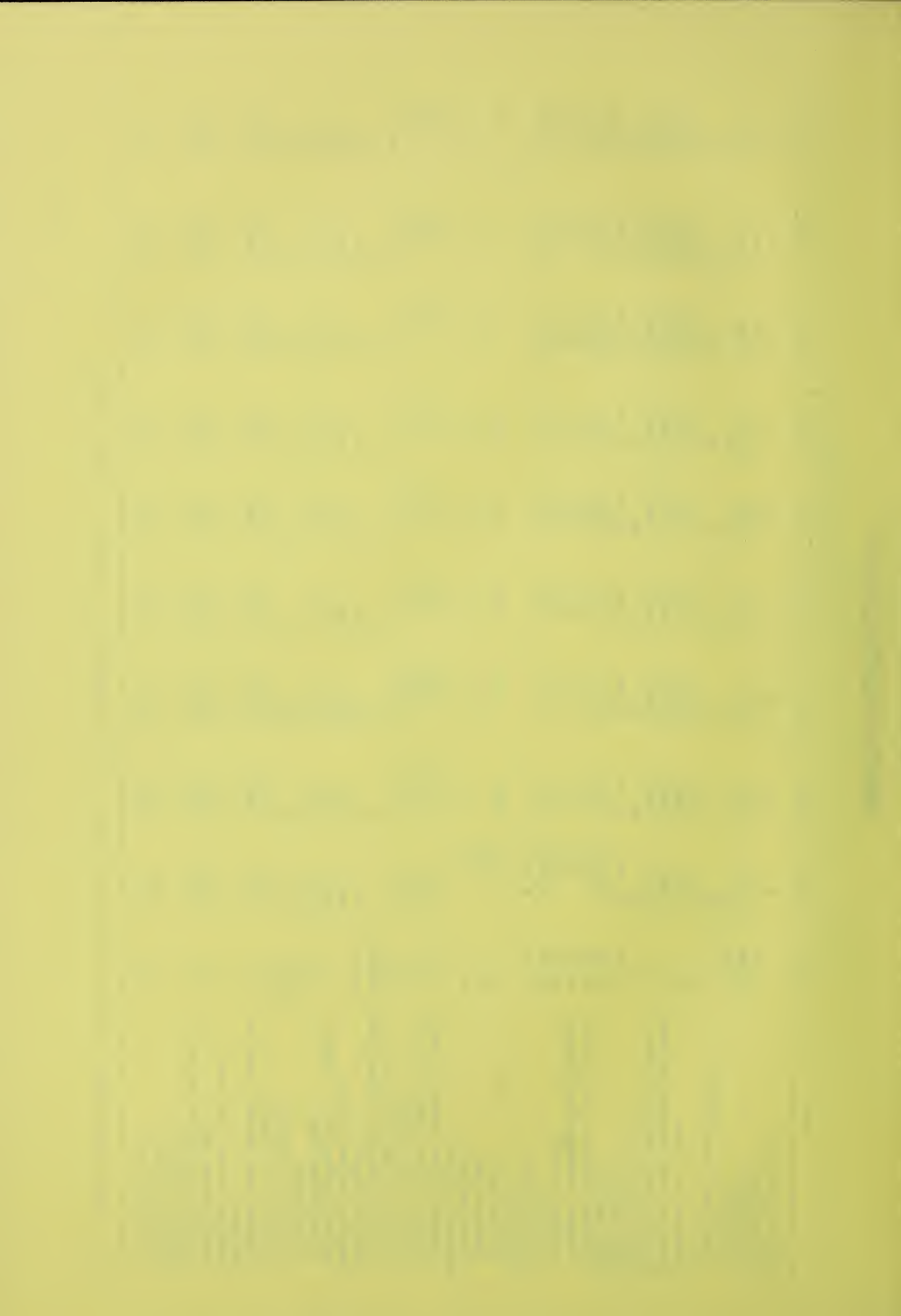


TABLE 3 - STRUCTURAL DATA (continued)

STRUCTURES WITH PLANNED STORAGE CAPACITY

Twelve Mile Creek Watershed, Iowa

Item	Unit	STRUCTURE NUMBER									
		40-1	D-41-A	D-44	D-44-1	46	48	49	55	58	
Class of Structure											
Drainage Area	Sq Mi	0.85	4.10	2.61	2.96	0.43	0.31	0.38	0.44	a	
Uncontrolled	Sq Mi	0.85	4.10	2.61	2.96	0.43	0.31	0.38	0.44	0.46	
Controlled	Sq Mi	-	-	-	-	-	-	-	-	-	
Curve No. (1-day) (AMC II)		79	79	79	79	79	79	82	79	79	
Tc	Hr	0.58	1.5	1.6	2.1	0.3	0.23	0.21	0.27	0.44	
Elevation Top of Dam	Ft	1122.0	1113.0	1137.0	1144.0	1125.5	1147.7	1142.0	1140.5	1160.5	
Elevation Crest Emergency Spillway	Ft	1118.0	1109.5	1132.5	1139.0	1123.5	1145.7	1140.0	1138.5	1158.5	
Elevation Crest High Stage Inlet	Ft	1108.0	1097.0	1118.0	1120.6	1116.0	1139.0	1131.0	1130.0	1152.0	
Maximum Height of Dam	Ft	33	38	36	40	28	25	27	27	24	
Volume of Fill	Cu Yd	36,000	56,000	47,000	64,000	16,000	18,000	16,000	23,000	30,000	
Total Capacity	Ac Ft	208.0	905.0	610.0	705.0	102.0	65.0	88.0	101.0	94.0	
Sediment Submerged 1st 50 years	Ac Ft	56.3	206.0	88.2	103.2	14.3	13.4	21.0	26.1	21.9	
Sediment Submerged 2nd 50 years	Ac Ft	7.6	74.0	33.8	39.8	26.7	8.1	6.6	8.7	11.0	
Sediment Aerated	Ac Ft	24.8	50.9	22.0	25.8	3.7	3.1	5.1	7.6	5.6	
Retarding	Ac Ft	119.3	574.1	466.0	536.2	57.3	40.4	55.3	58.6	55.5	
Municipal Water	Ac Ft	-	-	-	-	-	-	-	-	-	
Surface Area											
Sediment pool	Ac	9.2	26.0	16.8	18.0	5.8	4.8	4.4	5.4	6.7	
Municipal pool	Ac	-	-	-	-	-	-	-	-	-	
Retarding pool	Ac	19.9	81.5	58.0	63.2	10.6	8.7	9.2	10.3	12.1	
Principal Spillway											
Rainfall Volume (areal) (1 day)	In.	6.3	5.65	6.3	6.3	5.65	5.65	5.65	5.65	5.65	
Rainfall Volume (areal) (10 day)	In.	11.1	9.65	11.1	11.1	9.65	9.65	9.65	9.65	9.65	
Runoff Volume (10 day)	In.	6.31	5.08	6.31	6.31	5.08	5.08	5.63	5.08	5.08	
Capacity of High Stage (Max.)	cfs	65	170	71	74	34	30	33	34	31	
Frequency operation - Emer.Splwy.	% chance	2	4	2	2	4	4	4	4	4	
Size of Conduit	Dia./In.	24"	36"	24"	24"	18"	18"	18"	18"	18"	
Emergency Spillway - Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	
Rainfall Volume - (ESH) (areal)	In.	7.75	5.3	7.75	7.75	5.3	5.3	5.3	5.3	5.3	
Runoff Volume (ESH)	In.	5.27	3.07	5.27	5.27	3.07	3.07	3.35	3.07	3.07	
Bottom Width	Ft	82	70	144	110	30	30	30	30	30	
Velocity of Flow (Ve)	Ft/Sec	5.5	2.3	6.3	6.4	3.0	1.0	2.0	1.0	3.3	
Slope of Exit Channel	Ft/Ft	0.034	0.05	0.031	0.031	0.04	0.04	0.04	0.04	0.04	
Maximum water surface elevation	Ft	1119.5	1109.8	1134.4	1141.0	1123.7	1145.8	1140.2	1138.7	1159.2	
Freeboard											
Rainfall Volume (FH) (areal)	In	13.50	7.75	13.50	13.50	7.75	7.75	7.75	7.75	7.75	
Runoff Volume (FH)	In	10.76	5.27	10.76	10.76	5.27	5.27	5.62	5.27	5.27	
Maximum water surface elevation	Ft	1122.0	1113.0	1137.0	1144.0	1125.4	1147.4	1141.9	1140.4	1160.5	
Capacity Equivalents											
Sediment Volume	In.	1.95	1.51	1.03	1.07	1.95	1.43	1.61	1.82	1.57	
Retarding Volume	In.	2.63	2.62	3.35	3.40	2.50	2.42	2.73	2.51	2.26	

STRUCTURES WITH PLANNED STORAGE CAPACITY
Twelve Mile Creek Watershed, Iowa

Item	Unit	S T R U C T U R E N U M B E R									
		D-59	D-60	D-61	D-62-A	D-62-1	62-4	2/	62-5	67	4/
Class of Structure											
Drainage Area	Sq Mi	2.06	1.66	1.04	3.19	0.92	0.23		0.50	0.21	
Uncontrolled	Sq Mi	2.06	1.66	1.04	2.69	0.92	0.23		0.50	0.21	
Controlled	Sq Mi	-	-	-	0.5 3/	-	-		-	-	
Curve No. (1-day) (AMC II)		79	79	79	79	79	79		79	79	
Tc	Hr	1.5	0.90	0.5	1.1	0.9	0.20		0.42	0.20	
Elevation Top of Dam	Ft	1173.0	1174.4	1161.5	1193.6	1183.0	-		1216.7	1203.6	
Elevation Crest Emergency Spillway	Ft	1168.4	1170.0	1159.0	1188.0	1179.0	-		1213.0	1201.2	
Elevation Crest High Stage Inlet	Ft	1157.0	1158.2	1149.0	1174.0	1167.2	-		1202.0	1196.0	
Maximum Height of Dam	Ft	33	36	29	38	30	28		34	29	
Volume of Fill	Cu Yd	52,000	43,000	25,000	54,000	30,000	12,000		18,000	13,000	
Total Capacity	Ac Ft	504.0	410.0	224.0	607.6	182.0	35.3		100.0	47.8	
Sediment Submerged 1st 50 years	Ac Ft	93.5	92.1	55.7	96.0	34.0	10.1		13.3	8.0	
Sediment Submerged 2nd 50 years	Ac Ft	35.4	34.1	20.3	38.7	11.0	2.9		13.1	19.6	
Sediment Aerated	Ac Ft	23.1	22.8	14.2	45.3	8.0	2.3		3.5	1.8	
Retarding	Ac Ft	352.0	261.0	133.8	427.6	129.0	20.0		70.1	18.4	
Municipal Water	Ac Ft	-	-	-	-	-	-		-	-	
Surface Area											
Sediment pool	Ac	19.8	14.7	10.1	18.6	6.7	3.0		3.9	3.1	
Municipal pool	Ac	-	-	-	-	-	-		-	-	
Retarding pool	Ac	52.2	41.3	24.9	55.8	19.0	7.0		10.7	4.8	
Principal Spillway											
Rainfall Volume (areal) (1 day)	In.	6.3	6.3	5.65	6.3	6.3	-		6.3	-	
Rainfall Volume (areal) (10 day)	In.	11.1	11.1	9.65	11.1	11.1	-		11.1	-	
Runoff Volume (10 days)	In.	6.31	6.31	5.08	6.31	6.31	-		6.31	-	
Capacity of High Stage (Max.)	cfs	69	72	62	175	65	20		59	19	
Frequency operation - Emer.Splwy	% chance	2	2	4	2	2	2		2	2	
Size of Conduit	Dia./In.	24"	24"	24"	36"	24"	18"		24"	18"	
Emergency Spillway - Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.		Veg.	Veg.	
Rainfall Volume - (ESH) (areal)	In.	7.75	7.75	5.3	7.75	7.75	5.65		7.75	5.65	
Runoff Volume (ESH)	In.	5.27	5.27	3.07	5.27	5.27	3.37		5.27	3.37	
Bottom Width	Ft.	90	100	34	140	90	30		48	25	
Velocity of Flow (V _e)	Ft/Sec	6.4	6.3	3.2	6.9	5.8	-		4.7	5.6	
Slope of Exit Channel	Ft/Ft	0.031	0.031	0.05	0.03	0.033	-		0.038	0.04	
Maximum water surface elevation	Ft	1170.4	1171.9	1159.6	1190.1	1180.7	-		1214.1	1202.6	
Freeboard											
Rainfall Volume (FH) (areal)	In.	13.5	13.5	7.75	13.5	13.5	-		13.5	5/	
Runoff Volume (FH)	In.	10.76	10.76	5.27	10.76	10.76	-		10.76	-	
Maximum water surface elevation	Ft	1173.0	1174.4	1161.5	1193.6	1183.0	-		1216.7	1203.6	
Capacity Equivalents											
Sediment Volume	In.	1.38	1.69	1.63	1.37	1.08	1.22		1.13	2.63	
Retarding Volume	In.	3.20	2.96	2.41	3.26	2.62	1.60		2.63	1.65	

2/ Structure does not fall within the limiting criteria of SCS Engineering Memorandum 27; designed per SCS-Iowa criteria; surveys not available; quantities are estimated.

3/ Structure 62-4 was ignored in flood routing for design of this structure but credit was given for sediment storage.

4/ Structure does not fall within the limiting criteria of SCS Engineering Memorandum 27; designed per SCS-Iowa criteria.

5/ State SCS criteria requires a minimum of one foot of freeboard above the emergency spillway design flow.

STRUCTURES WITH PLANNED STORAGE CAPACITY
Twelve Mile Creek Watershed, Iowa

Item	Unit	68-1	68-2	71	72-1	72-2	73-4	77-4	TOTAL
STRUCTURES WITH PLANNED STORAGE CAPACITY									
Twelve Mile Creek Watershed, Iowa									
Class of Structure									
Drainage Area	Sq Mi	0.34	0.42	0.27	0.52	0.36	0.34	0.30	54.76
Uncontrolled	Sq Mi	0.34	0.42	0.27	0.52	0.36	0.34	0.30	
Controlled	Sq Mi	-	-	-	-	-	-	-	
Curve No. (1-day) (AMC II)		79	79	79	79	79	79	79	
Tc	Hr	0.33	0.35	0.25	0.26	0.31	0.31	0.30	
Elevation Top of Dam	Ft	1236.5	-	-	1248.0	1245.5	1256.8	1249.6	
Elevation Crest Emergency Spillway	Ft	1234.5	-	-	1246.0	1243.5	1254.3	1247.2	
Elevation Crest High Stage Inlet	Ft	1228.0	-	-	1238.0	1238.0	1249.0	1244.0	
Maximum Height of Dam	Ft	28	28	28	22	25	28	24	
Volume of Fill	Cu Yd	14,000	15,000	14,000	15,000	11,000	13,000	26,000	1,332,000
Total Capacity	Ac Ft	81.4	78.5	37.4	100.0	73.0	53.0	54.8	23,909.7
Sediment Submerged 1st 50 years	Ac Ft	11.7	11.9	9.6	16.6	11.6	11.5	8.2	2,625.3
Sediment Submerged 2nd 50 years	Ac Ft	23.1	3.9	2.9	7.4	16.4	11.3	19.3	1,632.5
Sediment Aerated	Ac Ft	2.8	2.9	2.2	3.9	2.7	2.7	2.0	632.0
Retarding	Ac Ft	43.8	59.8	22.7	72.1	42.3	27.5	25.3	11,019.9
Municipal water	Ac Ft	-	-	-	-	-	-	-	8,000.0
Surface Area									
Sediment pool	Ac	5.2	5.0	4.0	5.1	5.5	3.9	7.8	560.8
Municipal pool	Ac	-	-	-	-	-	-	-	633.0
Retarding pool	Ac	8.9	9.0	8.0	14.7	10.7	7.4	11.0	1,585.9
Principal Spillway									
Rainfall Volume (areal) (1 day)	In.	5.65	5.65	-	5.65	5.65	-	-	
Rainfall Volume (areal) (10 day)	In.	9.65	9.65	-	9.65	9.65	-	-	
Runoff Volume (10 day)	In.	5.08	5.08	-	5.08	5.08	-	-	
Capacity of High Stage (Max.)	cfs	34	34	34	34	35	39	31	
Frequency operation - Emer.Splwy	% chance	4	4	4	4	4	4	4	
Size of Conduit	Dia/In.	18"	18"	18"	18"	18"	24"	18"	
Emergency Spillway - Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	
Rainfall Volume - (ESH) (areal)	In.	5.3	5.65	5.65	5.3	5.3	5.65	5.65	
Runoff Volume (ESH)	In.	3.07	3.37	3.37	3.07	3.07	3.37	3.37	
Bottom Width	Ft	30	34	30	30	30	34	34	
Velocity of Flow (Ve)	Ft/Sec	1.0	-	-	1.0	2.6	5.7	5.5	
Slope of Exit Channel	Ft/Ft	0.04	-	-	0.04	0.04	0.04	0.04	
Maximum water surface elevation	Ft	1234.7	-	-	1246.2	1244.0	1255.8	1248.6	
Freeboard									
Rainfall Volume (FH) (areal)	In.	7.75	-	-	7.75	7.75	5/	5/	
Runoff Volume (FH)	In.	5.27	-	-	5.27	5.27	-	-	
Maximum water surface elevation	Ft	1236.5	-	-	1247.9	1245.2	1256.8	1249.6	
Capacity Equivalents									
Sediment Volume	In.	2.05	0.83	1.04	1.01	1.61	1.40	1.86	
Retarding Volume	In.	2.39	2.62	1.60	2.62	2.21	1.50	1.60	

2/ Structure does not fall within the limiting criteria of SCS Engineering Memorandum 27; designed per SCS-Iowa criteria: surveys not available; quantities are estimated.

4/ Structure does not fall within the limiting criteria of SCS Engineering Memorandum 27; designed per SCS-Iowa criteria.

5/ State SCS criteria requires a minimum of one foot of freeboard above the emergency spillway design flow.

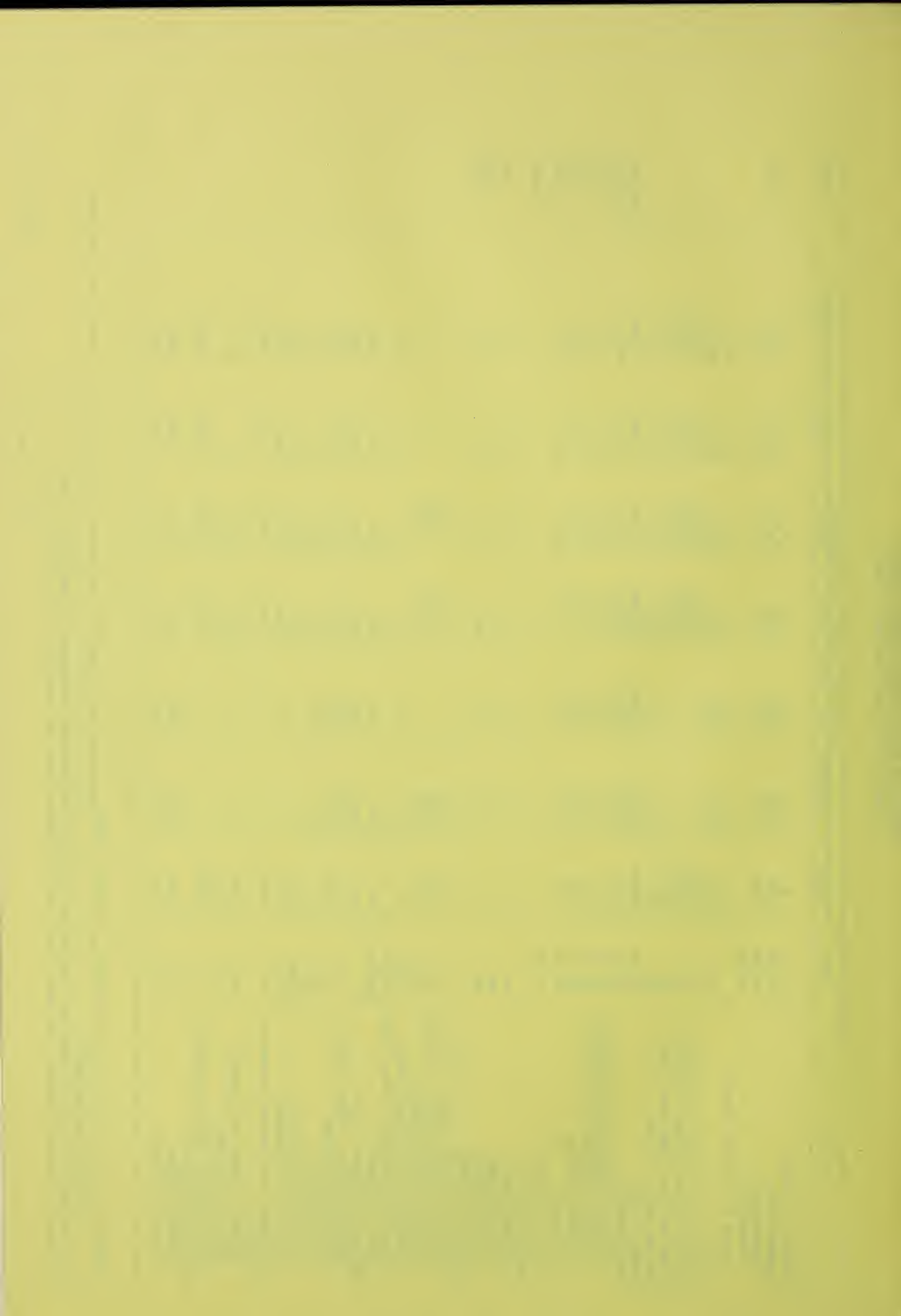


TABLE 3B - STRUCTURAL DATAGRADE STABILIZATION STRUCTURES

Twelve Mile Creek Watershed, Iowa

Site No.	: <u>Drainage Area</u> :			Drop	Concrete	Type of
	: Uncon-	: Con-	:			
	: trolled	: trolled	: Total			: Structures 1/
	(Acres)		(Acres)	(Feet)	(Cu. Yds.)	
74	150	-	150	6	35	D.S.

1/ DS - drop spillway

Date: November 1971

THE UNIVERSITY OF CHICAGO LIBRARY THE UNIVERSITY OF CHICAGO PRESS

Author	Title	Date	Volume	Page
[Faint text]	[Faint text]	[Faint text]	[Faint text]	[Faint text]

[Faint text at bottom left]

[Faint text at bottom right]

TABLE 4 - ANNUAL COSTS

Twelve Mile Creek Watershed, Iowa

(Dollars) 1/

		: Amortization :	Operation :	
Eval.:	Structural	: of :	and :	Total
Unit :	Measures	: Installation :	Maintenance :	
:		: Cost :		
(1)	(2)	(3)	(4)	(5)
1	All Structural Measures	144,160	8,760	152,920

Project			
Administration	12,150	XX	12,150
TOTAL	156,310	8,760	165,070

1/ Price Base: Installation Costs are based on 1971 price level and are amortized at 5 3/8 percent over 100 years.

Operation and maintenance costs are based on adjusted normalized prices, April 1966.

Date: November 1971

THE UNIVERSITY OF CHICAGO
DEPARTMENT OF CHEMISTRY
LABORATORY OF PHYSICAL CHEMISTRY

Run	Time	Temp	Pressure	Flow	Conc	Area	Ident
1	1.2	100	1.0	1.0	0.1	100	CH ₄
2	2.5	100	1.0	1.0	0.1	100	CH ₄
3	3.8	100	1.0	1.0	0.1	100	CH ₄
4	5.1	100	1.0	1.0	0.1	100	CH ₄
5	6.4	100	1.0	1.0	0.1	100	CH ₄
6	7.7	100	1.0	1.0	0.1	100	CH ₄
7	9.0	100	1.0	1.0	0.1	100	CH ₄
8	10.3	100	1.0	1.0	0.1	100	CH ₄
9	11.6	100	1.0	1.0	0.1	100	CH ₄
10	12.9	100	1.0	1.0	0.1	100	CH ₄

CHROMATOGRAM OF A MIXTURE OF METHANE AND ETHYLENE
OXYGEN. The mixture was prepared by passing a mixture of
the two gases over a catalyst of silver at 100°C. The
effluent was then passed through a column of Porapak Q
packed with 10% Porapak Q on 80/100 mesh Chromasorb P.
The column was operated at 100°C and 1.0 atm. The
flow rate was 1.0 ml/min. The detector was a flame
ionization detector (FID) operated at 250°C. The
response time was 0.1 sec. The data were collected
on a 100 MHz oscilloscope. The results are shown in
the table above.

CHROMATOGRAM OF A MIXTURE OF METHANE AND ETHYLENE
OXYGEN. The mixture was prepared by passing a mixture of
the two gases over a catalyst of silver at 100°C. The
effluent was then passed through a column of Porapak Q
packed with 10% Porapak Q on 80/100 mesh Chromasorb P.
The column was operated at 100°C and 1.0 atm. The
flow rate was 1.0 ml/min. The detector was a flame
ionization detector (FID) operated at 250°C. The
response time was 0.1 sec. The data were collected
on a 100 MHz oscilloscope. The results are shown in
the table above.

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Twelve Mile Creek Watershed, Iowa

(Dollars) 1/

Item (1)	Estimated Average		Damage Reduction Benefit (4)
	Annual Damage		
	Without	With	
	Project	Project	
	(2)	(3)	
Gully Erosion <u>2/</u>			
Land	28,460	830	27,630
Other Agricultural Damages	820	40	780
Non-Agricultural Damages	210	10	200
Subtotal	29,490	880	28,610
Floodwater			
Crop and Pasture	31,050	6,830	24,220
Other Agricultural Damages	8,770	430	8,340
Non-Agricultural Damages	13,110	630	12,480
Subtotal	52,930	7,890	45,040
Sediment	1,460	60	1,400
Subtotal	1,460	60	1,400
Indirect	8,380	260	8,120
Total	92,260	9,090	83,170
Downstream	XX	XX	13,910
GRAND TOTAL	XX	XX	97,080

1/ Price Base: Adjusted normalized prices, April 1966.2/ Damages and benefits are included for only the principal gully erosion areas which are affected by the project improvements.

Date: November 1971



TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Twelve Mile Creek Watershed, Iowa

(Dollars) 1/

		AVERAGE ANNUAL BENEFITS										
:	:											
		: Inci-	: M & I:	: More	: Changed:	: Secon-	:	: Average	: Benefit	:	:	:
Unit	Structural	Damage	dental	: Water:	Inten-	: Land	: dary	: Annual	: Cost	:	:	:
:	Measures	:Reduction:	Recrea.	: Sup-	: sive use:	: Use	: Bene-	: Total	: Cost	: Ratio	:	:
:	:	:Benefits:	ply	: of land	:	: fits	:	:	:	:	:	:
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)		
1	All Structural Measures	97,080	20,500	58,800	10,760	10,240	6,210	203,590	152,920	1.33 to 1.0		
<hr/>												
Project Administration		xx	xx	xx	xx	xx	xx	xx	12.150	xx		
<hr/>												
Total		97,080	20,500	58,800	10,760	10,240	6,210	203,590	165,070	1.23 to 1.0		

1/ Price Base: Adjusted normalized prices, April 1966, for benefits; costs from Table 4.

Date: November 1971



TABLE 7 - CONSTRUCTION UNITS

Twelve Mile Creek Watershed, Iowa

(Dollars) 1/

Construc- tion Unit	:	Structures	:	Annual Benefits	:	Annual Costs
1		67		860		710
2		68-1		1,270		920
3		68-2		1,400		1,140
4		71		1,090		870
5		72-1		1,190		1,120
6		72-2		1,200		940
7		73		880		880
8		74		820		620
9		77		1,550		1,550
10		M-1, D-59, D-62A, D-62-1, 62-4, 62-5		126,340		70,400
11		17, 18, 23, 27, 30, D-35, 35-2, 36, 40-1, D-41-A, D-44, D-44-1, 46, 48, 49, 55, 58, D-60, D-61 (M-1, D-59, D-62-A, <u>2/</u> D-62-1, 62-4, 62-5)		193,330		110,930

1/ Price base - 1971 price level for installation costs. Amortized at 5 3/8 percent over 100 years; adjusted normalized prices, April 1966, for maintenance costs.

2/ Structures not in parentheses are dependent upon prior or concurrent construction of those structures within parentheses.

Date: November 1971

INVESTIGATIONS AND ANALYSES

Land Use and Treatment Studies

An inventory of present land use was developed for the entire watershed area. This inventory included the present major classification of land use such as cropland, pasture, woodland, urban and other uses. The land treatment measures that have been installed on cropland and pasture areas were itemized for each land capability class. This inventory was developed from information of record and from the District Conservationist.

The amount of soil lost from sheet erosion under present conditions and with the planned land treatment measures installed, was studied and computed for use in formulating an adequate land treatment program for watershed protection.

A total conservation needs study was then made of the watershed area to show all of the land treatment measures that would be required to reduce soil loss from sheet erosion to tolerable amounts according to technical guides for the District.

In consideration of the above information, Service technicians with assistance of District Commissioners, developed a table of land use changes and land treatment measures that would be installed during the project installation period. The information was tabulated by various capability classes and indicated the land use, the mechanical practices, and the crop rotations that would be installed on the cropland areas. The land treatment measures to be applied during the project installation period represents the expected accomplishments of the Sponsors and farmers.

Erosion Investigation

A field reconnaissance was made to study the type and general extent of the erosion problems that are causing damage to land and to improvements in the watershed.

It was determined that sheet erosion is a problem on some of the sloping cropland areas that are still in need of land treatment. Gully erosion is severe in many areas and is causing voiding of crop and pasture lands and depreciation of adjacent and intervening areas. Damage to roads, fences, farm crossings, and other property from gully erosion has occurred at many places in the watershed.

Gully Erosion: Studies were made of the gully systems above all of the proposed structures in the watershed to determine the rate of land voiding by gully erosion and the rate of land depreciation which accompanies the expansion of a gully system. Depreciation is considered as a damage which occurs when land reverts to a less intensive use due to inaccessibility of areas for normal farm operations and the dissection of fields into small unfarmable units.

A set of 1938 and 1967 (8-inch to the mile scale) aerial photos of the areas was studied and the extent of the rate of gully erosion during that time was plotted on overlays and measured. With the aid of a set of 1967 (4-inch to a mile scale) photos the extent of the present gully erosion was field checked and recorded. These data were tabulated and computed to determine the present extent of voiding. The annual rate of voiding was obtained by dividing the difference between the voided areas, as determined above, by the number of intervening years.

Based on Technical Release No. 32, field observations, including interviews of local farmers and other people that could give helpful information on gully rates, these rates of growth were adjusted to provide estimates of future rates taking into consideration the amounts of land treatment measures that have been recently installed and those planned to be installed, the topography and gully gradients that would be encountered in any future gully advance; soil type; rainfall data; the change in depth of gullies; subsurface drainage; and the drainage area remaining and susceptible to future damage.

The upper limits of the 100-year gully growth in the natural waterway was the area considered as the voided area. All voided areas were assumed to change from crop or pasture to idle, since the hazard for livestock grazing is high and production of grass negligible. When future gully advance was limited by culverts with permanent floor elevations (not bridges), no area was considered as voided or depreciated above this point in relation to controls below. If there was an individual gully system developing above the road culvert, the voided and depreciation evaluation was made separately from that below the road.

Based on the expected future extension of the gully system, areas were delineated on the overlays to show those areas that would depreciate to a less intensive land use in the future 100-year evaluation period. From this information the annual rate of land depreciation was calculated.

Rates of land depreciation were based upon the following assumptions: (1) Areas of cropland isolated by gully growth would depreciate to pasture and pasture to idle if it were not practical or economical to farm or graze the land or install a crossing. This determination depended upon the size of the farm, cost of a crossing, and if the need for an intensive type of operation existed. (2) Areas along gullies extending from the voided area to the lowest terrace that can be safely installed, or dependent on structural measures for a stable outlet, were considered as depreciating from cropland to pasture or idle as each situation dictated.

Much of the depreciated land would revert to idle, due to lack of access, high fencing costs, and some hazards to livestock.

The volume of gully erosion without the project and with project was calculated for each structure drainage area. Field measurements in each drainage area were made to determine the width, depth and bottom width of gullies (cross-section areas). These were multiplied by the rate of gully advance to arrive at rates of gross erosion under present conditions. It was assumed that since most of the waterflow would be contained in the gully channels, such eroded material would be nearly all delivered as sediment to the downstream sites. The volume of sediment from gully erosion with the project installed was then calculated by considering the effectiveness of the project in reducing gully erosion and in retaining sediment in the conservation pools of the structures.

Sheet Erosion: Studies were made of the upland areas of the watershed to determine the rates of sheet erosion both without and with the installation of proposed land treatment measures.

The Universal Soil Loss Equation for Predicting Soil Loss in Iowa was used to compute soil losses by sheet erosion on the basis of cover, slope length, percent of slope, soil characteristics, rainfall, and management practices. The data needed for these computations were obtained from the local SCS District Conservationist, area staff, and soil scientist and State technical staff, farm plans, field inspection, and a study of soil conservation surveys. The volume of sheet erosion under existing conditions and the volume with the project installed was thus developed for the entire watershed.

Sheet erosion from a sizeable area of the watershed has been reduced to what is considered a tolerable amount by terracing, contour farming, strip cropping, crop rotations, pasture improvement and by other improved land management practices. Similar reductions will occur on additional areas receiving treatment measures scheduled in this work plan.

An estimate of sheet erosion delivery ratio from an envelope curve formulated from Iowa survey data, was used for structure sites and based upon other general information secured in past studies. It was estimated that a range from 20 to 60 percent of the gross sheet erosion is transported to downstream sites as sediment. The losses that occur in transit are deposited on the colluvial and alluvial slopes, in the valleys, in road ditches and channels, along fence lines, and in or adjacent to waterways.

Erosion estimates and estimates of the sediment conveyed to all structure sites in the watershed were recorded on SCS Form 309. Information from this form was used by the engineer in providing for sediment storage needs in the design of the structures.

Sediment Damage: Sediment from the various drainage areas is causing downstream damages. These damages are being caused by the sands and silts of 12 to 24 inches in depth shifting from place to place and covering crops. The material from this source is also very unproductive and needs to be mixed with adjoining soils, in order to bring these areas back into production.

Each lateral that had evidence of sediment deposits was studied and evaluated. Area affected annually and the percent of yield reduction was estimated.

Structures located above the evaluated areas for sediment damages, will have approximately 97 percent trap efficiency for reduction of damages from sediment.

Other Damages: Preliminary investigations revealed that swamping, scouring and other damages were negligible and therefore were not evaluated.

Geologic Investigation

A field reconnaissance was made of the watershed to observe the geological, physiographical, and other features of the watershed which might influence the selection of satisfactory sites and the design of structural measures. Construction experience in other watersheds with somewhat similar characteristics was used as a guide in appraising the geological feasibility of structure sites that were selected.

All proposed structure sites were observed by the geologist and by the planning engineers. A geologic investigation was made at site M-1 using a Service operated drill rig. The foundation, spillway, and borrow areas were identified, sampled and samples analyzed in the SCS Soil Mechanics Laboratory at Lincoln, Nebraska. Based upon these findings, observations of the various sites, and previous experience at similar sites, it appears that foundation conditions are suitable and satisfactory borrow materials are available. Further site investigation, as required, will be made at other sites prior to construction. The extent and complexity of these investigations will vary from site to site and will be governed by variations in materials encountered. Sufficient funds have been included in the estimate of engineering design for this purpose.

Hydraulic and Hydrologic Investigations

Several alternative plans of structural works of improvement were investigated for the watershed. The most practical and feasible plan, from the engineering and economic viewpoints, is included in the project.

Weather Bureau Technical Paper No. 40 was used to determine the amount and frequency of rainfall to be expected in this area for storms of different durations. Rainfall data were used for estimating amounts of runoff because no stream gages are located in the watershed.

Information on the hydrologic condition of the forest land in the watershed and the reasons for the present hydrologic condition were obtained from a series of systematically selected field plots. This information served as the basis for developing precipitation-runoff curve numbers and land treatment needs for forest land. The data obtained included measurements of litter and humus layers, determination of soil type and other hydrologic factors, and recording the presence or absence of disturbance factors such as fire, grazing, cutting, logging and the abnormal infestation of insects or diseases which might adversely affect hydrologic conditions or increase the fire hazard.

The hydrologic runoff curve numbers were computed for the present land use and treatment and for the anticipated future land use and treatment. The runoff curve number is an index of the runoff producing potential of an area as related to the local soil types, cover conditions, and land treatment. These runoff curve numbers were used to estimate the runoff volumes to be considered in the design of the detention structures and in the evaluation of the extent and frequency of flooding. The runoff curve number was used, in conjunction with ES-1027, to determine peak flow requirements for full flow structures.

The evaluation of the extent and frequency of flooding was made using Technical Release No. 20 - Project Formulation Program - Hydrology.

The hydraulic characteristics of the nineteen reaches were determined for range for each reach. Available guides and pictures were used in the determination of Manning's roughness coefficient "n" for each range. Stage-discharge-area inundated data were developed for each range using the Soil Conservation Service Water Surface Profile Program.

Runoff amounts for eight rainfall events, ranging in frequency from 0.5 years to 100 years, were routed through these reaches to determine the peak flow discharges.

The extent and frequency of flooding, as determined by these methods, was field checked by interviewing farmers within these stream reaches. The interviews supported the 'present condition' routings.

Downstream benefits on the Thompson River floodplain were evaluated to Davis City, Iowa. The hydraulic characteristics of this floodplain were determined by six ranges; one for each reach. The above listed programs were used to determine the frequency and extent of flooding. The peak flows obtained were adjusted to the peak flows as determined by an analysis of the gage records at the Davis City gaging station.

The storage requirements for municipal water determined by the engineering consultant firm for the City of Creston were checked and found to be reasonable. A water budget analysis was made to determine the adequacy of the municipal storage. This analysis covered the period of the worst drought of record from August 1953 through March 1957 and showed that the storage was adequate to supply the municipal water requirements for these conditions.

Seepage losses from the reservoir created by structure M-1 are estimated to be very low. The floodplain consists of 16 to 21 feet of CL alluvium overlying an 8-foot layer of slowly permeable SM and SC soil. The SM and SC soil is underlain by additional CL soil. These floodplain soils were derived from the Kansan and Nebraskan tills and from the Aftonian interglacial material that lies between them. The water table in the floodplain is high - four to five feet below ground surface right of channel and seven to nine feet below ground surface left of the channel. A test hole 30 feet from the right channel bank had a water level six feet above the channel bottom. Permeameter tests made on the floodplain soils were so low that dependable results could not be obtained.

The sides of the reservoir consist of CL soils of the Kansan till. These soils are slowly permeable.

The left abutment has a lens of Aftonian sand. This sand lens from present drilling pinches out upstream and downstream. During stripping operation this lens should be investigated by the engineering geologist and if necessary the embankment on the left abutment moved upstream to form a blanket over the upstream side of the low hill that forms part of the left abutment.

Economic Investigations

The evaluation of gully erosion damage to land was based on the annual land losses from voiding and from depreciation to less intensive use of the adjacent fields. These annual rates, for voiding and for depreciation, were multiplied by the per acre damageable values to find total damages that occur at each site. These per acre values represent losses that will occur in years that follow, since the damage cannot be recovered.

The land use and crop rotations considered for these evaluations were those which are within the criteria and standards of the use capabilities of the land, determined through soil surveys and land use capability classifications. The level of yields used were those obtained by farmers following a moderately high level fertility and management program and an intensity of farming operations consistent with the most intensive practical cropping pattern applicable within the area. Where associated soil and water conservation measures were necessary to make possible the above level of intensity of farming, the average annual value of the cost of these required associated measures were deducted from the total average annual damage.

The gross income from the land affected was determined on a per acre basis as the monetary values of all the products grown on the area, e.g. field crops and pasture, times their respective normalized price per unit.

These values, when combined and weighted, gave the composite per acre gross income figure for the land that would be voided and depreciated without the proposed project.

The gully damage evaluation takes account of: (1) Loss of income to farm operators during a ten-year adjustment period, (2) market value of the loss to landowners of a land resource, (3) value of the loss to local public interests of real estate tax base income, and (4) value of the loss to public interests not reflected in the market values of a land resource.

Damages without the project, with land treatment measures, and with the structural measures installed were computed.

All of the above procedures, and the methods involved, are set forth in the SCS Economics Guide, Chapter 5, "Appraisal of Sediment and Erosion Damage". Crop yield data for soils of these areas were based upon interviews, SCS technicians and material published by ERS for Missouri River Basin for projected yields for years 1980, 2000 and 2020, the experience of farmers who have practiced conservation farming, and SCS technicians.

Gully erosion damage to land occurring in other small areas of the watershed was studied; however, project structural measures in those areas could not be economically justified and therefore were not included.

Floodwater damages to crop and pasture were determined by flood routing. Various alternative plans of structural measures were used to determine which alternative would be used for the final plan. The plan selected consists of 22 floodwater detention structures and one multiple-purpose structure for flood prevention and water supply for the town of Creston. This plan gives a reduction of 78 percent in annual floodwater damages to crop and pasture. There are also 11 grade stabilization structures.

Yields for various crops were determined from interviews with farmers and local SCS technicians. Material published by ERS for the Missouri River Basin for projection of yields for the years 1980, 2000, and 2020 was also used as a guide in arriving at yields used for evaluating damages.

Estimated floodfree crop yields on the bottomlands used for evaluation are as follows:

	<u>Without Project</u>	<u>With Project</u>
Corn	120 bu.	140 bu.
Soybeans	45 bu.	50 bu.
Pasture	150 cpd.	180 cpd.

Land use was obtained from observation in the field, aerial photos, and with assistance of the local SCS technicians.

The net income of composite acre for without and with project was prepared and used in determining value per acre. The number of acres were obtained from interviews. Farmers indicated that they will intensify the use of 1,490 acres of land after the structural measures have been installed. Necessary discounting was computed to arrive at value shown in Table 6.

Farmers indicated that with protection from floodwater damages, 430 acres of pasture land would be placed into crop production. The net income value for composite acre without project was subtracted from net income value for composite acre with project. The difference was multiplied by the acres to be placed into production. Associated costs at seven percent interest were deducted and necessary discounting was completed to arrive at value shown in Table 6.

The geologist determined annual acres affected by sediment from field observation. He also estimated the percent of damage for each crop. The economist prepared values for no damage, 10 percent, 30 percent, 50 percent, and 70 percent damage to crops. Damages were then evaluated according to procedures shown in Economics Guide, Chapter 5, page 11.

Indirect damages were computed at 10 percent of the floodwater damages and 15 percent of the road damages. These damages include the additional expense and loss of time of operators used for repairing and clean-up after floods. It also includes additional distances driven by farmers, vehicles of local business establishments such as fertilizer and feed trucks, and school busses, etc., because of flooded road crossings.

Information needed for farm fences and farm crossings were obtained from field observation. Boundary fences were the only fences evaluated. Length of fence affected by gully erosion or floodwater was determined and multiplied by the cost per foot to arrive at the benefit.

Farm crossings were evaluated from the standpoint of reduction in maintenance costs. This is due to reduction in growth of gully or control of water flow from the structural measures proposed in the project.

Information for roads and bridges was obtained by field observation, use of information from other watersheds and from interview with the Union County Engineer. Reduction in costs for maintenance, repair and replacements were considered as a benefit to the project.

Incidental recreation benefits were evaluated for structure M-1. It was estimated that the minimum facilities to be provided will accommodate 31,500 visitor days. The estimated value per day is 80 cents with a cost of 15 cents per day for installation, operation, maintenance and replacement of recreation facilities. This gives an estimated value for incidental recreation benefits of \$20,500.

Downstream benefits to the Thompson River floodplain were determined by using the SCS project formulation - economic program. Four different alternatives were evaluated. Benefits were pro-rated by use of the fair share method. This is a method giving consideration to the effect a designated area may have upon the entire benefits of a large drainage area. Benefits are pro-rated back to the specific area in the same ratio as to its effects. It was estimated that \$13,910 of downstream benefits are attributable to Twelve Mile Creek Watershed.

Cost of land for the necessary land rights for all structural measures was obtained from two local land appraisers. They estimated the value of cropland at \$500 per acre and pasture or other land at \$150 per acre. Where flowage easements are needed, their value was estimated to be one-half of the estimated land values. Land values of the sediment pool area of structures were based on 100 percent of its value, and for the remaining area above the sediment pool, the land value is based on 50 percent of its value. For mitigation measures in small odd areas, a value of \$50 per acre was used.

These costs were agreed upon by the local sponsors and the Service.

Secondary benefits that will accrue within the immediate zone of influence of the project were considered in computing the benefits accruing to the project. Secondary benefits from a national viewpoint were not considered pertinent to the economic evaluation.

Secondary benefits are the values added over and above the immediate products or services of the project as a result of activities "stemming from" or "induced by" the project.

Installation costs of structural measures were amortized at 5 3/8 percent interest for a period of 100 years. Operation and maintenance costs were computed at 0.35 percent of the estimated construction cost of the structural measures.

The "use of facilities" method was used in allocating costs of the multiple-purpose structure, M-1. Allocation of costs to purpose is shown on Table 2A.

The City of Creston indicated that benefits for the municipal water supply could best be measured by alternative costs for a single purpose adequate water supply. The site of M-1 appeared to be the best available. Hence, a single purpose water supply structure at this site was designed and cost estimates developed and amortized and O and M added to give the average annual benefits of \$58,800.

Engineering Design and Cost Estimates

The design of structural measures is based on applicable SCS criteria and design procedures. These include SCS national and State Engineering Handbooks, Engineering Memorandum SCS-27 and other sources of recognized engineering design material.

A stereoscopic study of aerial photographs and the USGS topographic map that provided only partial coverage was studied to select potential sites for floodwater, sediment, and gully stabilization structures. A field examination of each potential site was then made by the planning engineer and area engineer to develop definite structure proposals. Topographic maps were developed by photogrammetric method from medium level flights for all water storage sites except four of the smaller grade stabilization sites that do not come under Engineering Memorandum SCS-27 criteria.

Other information used in selection of sites included the size of drainage area, location of overfalls, property lines, suitability of site, field access and road problems, wildlife and forest land involved, and other information gathered by members of the planning party in regard to damages that included flood and sediment damages.

The State Conservation Engineer, area engineer, District Conservationist, and all the local sponsors were consulted when necessary to develop agreement and understanding regarding the structure or combination of measures that would best meet the needs. The local sponsors selected the site for the multi-purpose structure from three alternative proposals analyzed by the Planning Party. Estimates of construction costs and benefits were nearly identical for these three sites.

Provisions are made for a minimum of 100-year sediment capacity for all the detention type structures. The crest of the principal spillways for nine of the floodwater retarding structures (D-35, D-41A, D-44, D-44-1, D-59, D-60, D-61, D-62A and D-62-1) will be set at the top of the 50-year sediment pool as required by SCS National Engineering Memorandum 27. The second 50-year sediment storage will be provided for between the crest of the principal spillway and the crest of the vegetated emergency spillways. All of these nine structures will be designed with standard reinforced concrete risers, standard propped outlets, and reinforced concrete culvert pipes ranging in size from 24 to 36 inches in diameter. The average normal pool surface area of these nine structures is 16.4 acres with a range in size of 6 to 26 acres. Of the other 23 detention structures, 13 will provide grade control.

All but three of these 23 structures will have principal spillways of reinforced concrete culvert pipe ranging in size from 18 to 24 inches and are designed with standard open concrete risers on hood inlets. Structures 30 and 62-5 are designed with reinforced concrete chute outlets to permit the county to raise the inlet of the culvert downstream of 30 and the railroad to do the same downstream of site 62-5. Structures 62-4, 67, and 73 are designed with corrugated iron or steel pipe with hooded inlets and corrugated metal chute outlets.

With chute outlets required, it was more economical to design these with corrugated metal pipes. As part of the maintenance on these three structures, it is anticipated that these corrugated metal pipe principal spillways will need to be replaced once after 50 years to provide 100-year structure life. Seventy-three is designed with a 24 inch diameter pipe and the other two with 18 inch diameter pipe for principal spillways. The average normal pool surface area of these 23 structures is 6.3 acres with a range in size from 3 to 11 acres.

The principal spillways of structures 40-1, D-44, D-44-1, D-59, D-60, D-62A, D-62-1 and 62-5 are designed to have the capacity to handle peak runoffs anticipated from a 50-year rain storm without the vegetated spillways functioning. The principal spillway design runoff (50-year) for structure M-1 was increased by 20 percent to reduce the volume and duration of emergency and freeboard flows. This provided greater than 100-year capacity in M-1 before emergency spillway flow started. All the other water reservoir detention type structures are designed to handle runoffs from anticipated 25-year rain storms. All these detention type structures will be provided with vegetated emergency spillways.

Ten foot wide berms will be constructed at or near crest elevations of all the detention structures for wave erosion protection. Additional wave erosion protection by rock riprap will be provided on some of the larger floodwater retarding dams most effected by prevailing winds.

A consultant was hired by the City of Creston to determine their municipal water needs. The amount of municipal and industrial water provided for is based on the consultant's recommendation that 8,000 acre-feet be supplied.

The multiple-purpose structure M-1 is designed with a 48 inch diameter reinforced concrete culvert pipe with a concrete riser and SAF outlet. This structure will also be provided with a gated drawdown pipe for water management and maintenance. Riprap will be provided on the upstream face for wave erosion protection from the lowest anticipated drawdown of municipal water (elevation 1159.0) to eight feet above the crest (elevation 1185.0). The earth fill for this structure will consist mostly of CL materials. A five-foot deep cutoff trench is planned and for drainage a trench drain with blind wells will be used.

The one full-flow grade stabilization structure included in the project is designed using an anticipated 25-year peak flow. It will be a reinforced concrete straight drop spillway.

No channel improvement is proposed except for short reaches downstream of some of the structures for principal spillway alignment with the downstream channel.

PROJECT MAP TWELVE MILE CREEK WATERSHED

ADAIR, RINGGOLD AND UNION COUNTIES, IOWA

TOTAL DRAINAGE AREA 50,030 ACRES



PROJECT MAP TWELVE MILE CREEK WATERSHED

ADAIR, RINGGOLD AND UNION COUNTIES, IOWA

TOTAL DRAINAGE AREA 50,030 ACRES

